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MANUAL

ON DEMOGRAPHIC SAMPLE SURVEYS

IN AFRICA

UNITED NATIONS ECONOMIC COMMISSION FOR AFRICA

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

September 1974

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INTRODUCTION

Background

The need for a more precise knowledge of the principal demographic parameters and their rates of change, as fundamental variables for development planning, is today accepted throughout Africa. Yet there is no African country which has a fully operative system of civil registration and in many areas census data are rudimentary or non-existent. As a result of this situation, modern Africa has seen a flowering of the sample demographic survey as a tool for population measurement. Such surveys are relatively cheap and easy to control, can be mounted in countries at any stage of development, and are able to provide most of the information needed by the development planner at an acceptable level of precision. Today, there is practically no independent country in Africa which has not carried out at least one sample demographic enquiry, covering part or all of its population. 1/

This extensive work, stretching over more than a decade, has led to the accumulation of a mass of practical experience. However, many of the persons most closely involved - both African and expatriate - have been moving on to other work; in these circumstances there was a danger of the existing stock of experience being dissipated before it could be passed on to future generations. It was with this situation in mind that the Statistics Division of the Economic Commission for Africa proposed the preparation of a manual of demographic survey techniques which would attempt to bring together and evaluate as much as possible of what had been learned from African experience in this field. A plan of the proposed manual 2/ was presented for the consideration of the 6th session of the Conference of African Statisticians in Addis Ababa in 1969. The Conference approved the principle of the preparation of such a manual and made numerous suggestions as to its content. The work of drafting the manual was entrusted to Mr. Christopher Scott and Mr. J.G.C. Blacker, ECA Regional Advisers in, respectively, Sample Surveys and Demographic Statistics.

The work progressed slowly, under competition with other commitments of the authors. Mr. Scott transferred to the United Nations Educational, Scientific and Cultural Organization in 1970. To ensure continuation of the project, UNESCO agreed thereafter to share responsibility for the manual with ECA. In 1971 a draft of the chapters now numbered 1-7 and 9 was presented to the 7th session of the Conference of African Statisticians in Dakar; 3/ the Conference reaffirmed its general support and made a number of suggestions for improvements. The same draft was also presented in December 1971 to the

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1/ For a complete list of African demographic surveys, see ECA document E/CN.14/SM/19; also Occasional Paper No. 4 of the World Fertility Survey.

2/ Document E/CN.14/CAS.6/22.

3/ Document E/CN.14/CAS.7/17.

1st session of the Conference of African Demographers and the African Population Conference, both held in Accra, and a fuller draft was presented to the 8th session of the Conference of African Statisticians. 1/

ECA and UNESCO wish to thank the many specialists who took time to read part or all of the earlier drafts and to offer suggestions for improvements. While the authors take final responsibility for the opinions expressed, the manual should be seen as a co-operative work reflecting the knowledge, experience and ideas of a large number of individuals who have worked on demographic surveys in Africa. Virtually all of those who have such experience have had the opportunity to comment on earlier drafts and all significant comments received are reflected in the final draft.

Purpose and coverage of the manual

The manual is intended primarily for use in government statistical offices in Africa, and in particular by the person in such an office who is given the responsibility of planning, organizing and directing operations in a demographic survey. It should also be useful to the Director of the office himself; hopefully, he may find that the detailed table of contents as well as the summaries which follow all the longer chapters will enable him to pick out those topics of particular concern to him.

Bearing in mind the needs of such professional statisticians and demographers, possessing already a broad training in their subject and a certain amount of experience in field operations, the authors of the manual examine one by one the main practical problems which have to be solved in drawing up a specific survey plan, and propose concrete solutions based on the experience of the many demographic surveys already successfully completed in Africa. The primary aim of the manual is thus to ease the load on the survey planner by offering him the digested experience of others who have gone before, with material arranged so as to be directly applicable to the task with which he is faced when he comes to plan and direct his survey.

The specific orientation of the manual towards government users implies an emphasis on a particular type of survey. There is a background assumption throughout the manual that we are dealing with a large-scale survey, based on scientific sampling, motivated ultimately by the needs of development planning and, specifically, aiming to estimate the current size and characteristics of the population and/or their rates of change. In the past, virtually all African demographic surveys organized by government statistical offices fall within this category. In recent years there have been signs of a developing interest in some offices towards more specialized studies of fertility and family planning. Surveys of this kind are not explicitly covered in the present manual - not because they are considered any less important but because they raise a range of special problems, treatment of which would extend the manual to an unacceptable size. Such surveys have been discussed in detail in

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1/ Document E/CN.14/CAS.7/17/Rev.1

a manual prepared by the Population Council 1/ and further handbooks and documentation can be expected to appear in coming years in connexion with the World Fertility Survey.

Another significant category of survey not explicitly treated is the type of deep-probing enquiry, of limited geographical coverage often informally sampled, designed as a research project to throw light on the special difficulties of collecting information on some limited demographic topic, such as age, or fertility history. Such methodological studies, often bordering on anthropology, are becoming increasingly common as African universities extend their interest into demographic research. While they are not treated in this manual, they seem likely to lead ultimately to important improvements in the methodology of censuses and large-scale surveys.

It is hoped also that the manual will be found useful in African demographic and statistical training institutes, although here a word of warning is necessary. The desire to help the practical survey planner has led to a deliberate narrowing of the presentation in the manual, with a view to giving clear recommendations wherever feasible; discussion of fringe options has generally been avoided and a whole range of fundamental issues are hardly mentioned - such as the motivation for doing demographic surveys and the use to which the results are put. It would be generally agreed that a course on demographic surveys at university level should bring the student into contact with a wider range of issues than those of survey technology. Thus, while the present manual may make a useful contribution to such a course it would clearly need supplementing by other materials carefully designed to broaden the student's view of this area.

Finally the manual does not directly treat manpower surveys. Such surveys are sometimes combined with conventional demographic surveys, either as an extension of the interview or in the form of a separate interview directed to a subsample of respondents. The former case is treated briefly in Chapter 5 but the latter arrangement is clearly outside the scope of this manual. Once again, this exclusion is not intended to imply that manpower enquiries are any less important; the purpose is merely to keep the manual to manageable size. There would seem to be a good case for the preparation of a separate manual on manpower surveys.

Contents of the manual

In order to keep the manual within reasonable bounds, it has been deliberately limited not only as to the type of survey but also as to the subjects treated. The main limitation as regards subject matter is the almost complete exclusion of demographic analysis. This field is both too large to allow of adequate treatment in the same volume as the subject of data collection, and too rapidly growing in its African applications to justify any attempt to be definitive. Thus the analysis, and more generally the use, of demographic data is discussed only where this is necessary for an adequate treatment of the data collection problem.

1/ The Population Council. A Manual for Surveys of Fertility and Family Planning: Knowledge, Attitudes and Practice, Key Book Service, New York, 1970.

This is therefore essentially a manual of data collection technique.

Chapters 1, 2 and 3 are largely descriptive in character, outlining the main categories of demographic surveys (within the broad central category which constitutes the field of coverage of the manual).

Chapter 4 deals with two basic questions of definition: the choice between de facto and de jure enumeration and the definition of the household.

Chapter 5 - Topics for Investigation and Content of the Questionnaire - assumes that the main objectives are given and discusses the choice of questions and methods to achieve these objectives. Chapter 6 goes into details about the precise form of the questionnaire.

Chapters 7 and 8 deal respectively with sampling and estimation, including sampling error estimation.

Chapter 9, dealing with Organization and Field Work, gives a very concrete discussion of the practical problems of organizing a field survey. While the subject matter of most of the other sections of the manual has been covered in many other publications, this chapter seems to break new ground: perhaps the problems treated here are so severely practical that they have not hitherto seemed to merit the dignity of publication. It may be noted also that much of this chapter would be found applicable to African surveys in fields other than demography.

Chapter 10 concerns data-processing. This again is a rapidly developing field and a definitive treatment did not appear feasible. The chapter therefore covers only a selection of problems in this area.

Chapter 11 discusses two special techniques of data collection widely used for estimating vital rates in developing countries: the multi-round follow-up survey and the dual record system (PGE).

Chapter 12 gives a brief summary of the main analytical methods which have been developed by Brass and others for dealing with defective data and this leads on to a brief discussion of the strategy problem: how to select the most appropriate technique.

It will be seen that there is no chapter specifically allocated to non-sampling error or its operational counterpart, quality control. This crucially important topic is not neglected in the manual; but the causes, and remedies, for non-sampling error are many and these are treated in several chapters at each point where they appear relevant.

As mentioned above, the treatment is severely practical. One result of this is that the manual does not discuss every possible solution to every problem, but only those solutions which seem to be reasonably close to optima. Another result is that clear-cut recommendations are given wherever possible. The authors are aware that they may have gone too far in the latter respect. Every country situation is different and every survey is a special case; it could be argued that in these circumstances there is no justification for importing recommendations from outside the country. There is much truth in

this, but it is also true that a manual without explicit recommendations would miss its main purpose of assisting the survey planner by providing him with a quick and practical summary of the experience of others. After careful consideration it was decided to retain most of the recommendations but to stress in this Introduction that they are in no sense binding or authoritative. In particular, they do not have the weight of United Nations authority behind them: they are rather to be seen as a convenient way of summarizing accumulated experience. They can be set aside at will in any country. The authors' only plea is that, if any of them is set aside, this should not be done lightly but only after careful thought.

The longer chapters are each followed by a brief summary, for the convenience of the hurried reader. Inevitably, in these summaries the recommendations appear even more bluntly than in the main text, often stripped of reservations. This, too, should be borne in mind.

Finally it should be stressed that hardly one of the conclusions or recommendations is strictly definitive. This is still a growing field of knowledge. In almost every instance, far more experience is needed before it can be said that this or that procedure of demographic data collection is clearly the best that could be devised.

Relationship to other manuals and handbooks

A manual of African demographic problems entitled Sources et analyse des données démographiques was published in 1973-74 jointly by four official French organizations: INED, INSEE, ORSTOM and SEAE. This is in three parts: Part I - Sources of data; Part II - Adjustment of defective data; Part III - Analysis of data. The presentation is a compilation of separate articles rather than an integrated work. Only one chapter covers specifically the subject of demographic surveys and this is a condensation of the present UN/UNESCO manual. The other chapters deal with other methods of data collection and procedures for analysis. Thus the manual is complementary to the present work. It concerns specifically the French-speaking African countries and will be appearing in French only.

A handbook on the dual record system (PGE) is being prepared by the Population Council and will be appearing in 1974. 1/ The subject is treated briefly in Chapter 11 of the present manual but readers are referred to the Population Council handbook which gives a very thorough and detailed treatment. The handbook is not specifically oriented towards any one region of the world.

A series of manuals are being produced at intervals by the Laboratory for Population Studies (POPLAB) of the University of North Carolina, each dealing with a particular topic related to population measurement. Three have already appeared: Mapping and House Numbering, Operational Control of Sample Surveys, and Designing Forms for Demographic Surveys. While these are not based specifically on African experience they should be consulted by any organization planning a demographic survey.

1/ Marks, E., Seltzer, W. and Krotki, K. (1974), Population Growth Estimation: A Handbook of Vital Statistics Measurement, Population Council, New York.

A number of manuals are available which deal specifically with population censuses, but which are closely relevant to demographic surveys. The following may be particularly noted:

Handbook of Population Census Methods, United Nations, Series F, No. 5, Rev.1 3 volumes, 1958-59.

African Recommendations for the 1970 Population Censuses, Economic Commission for Africa, 1968 (E/CN.14/CAS.6/1).

Manual on the Training of Population and Housing Census Personnel, Economic Commission for Africa, 1971 (E/CN.14/CAS.7/5).

The second and third of these cover part of the ground treated in our chapters 5 and 9 respectively.

Finally, reference should be made to the various earlier manuals of the United Nations covering some of the topics of this manual:

Recommendations for the Preparation of Sample Survey Reports, United Nations, Series C, No. 1, Rev.2, 1964.

A Short Manual of Sampling, United Nations, Series F, No. 9, 1960.

Handbook of Household Surveys, United Nations, Series F, No. 10, 1964.

Manual on Training of Statistical Personnel at the Primary and Intermediate Levels, United Nations Economic Commission for Asia and the Far East, 1971.

These and other publications could be usefully consulted by anyone planning an African demographic survey, though none of them cover the whole area systematically in the same manner as the present manual.

Why a specifically African manual?

It may reasonably be asked how far the present manual would be useful outside Africa, or what are the special features of African surveys which may make this manual specific to that continent? While there is much variation between African countries, the following features are very widespread and are perhaps particularly significant in their effect on the organization of any demographic survey.

(1) The mapping problem. Most African countries possess a list of small administrative or census areas which can be roughly located on the groun and which may serve as sampling units, but in nearly all countries these are not very clearly defined as to their boundaries. This affects the sampling problem, as will appear in Chapter 7. Only very rarely in Africa do we find any list of dwellings or households which can be used as a sampling frame.

(2) Identification. In most African countries there is difficulty in identifying a given individual unambiguously by means of names. In addition there are only a few areas where a strict system of addresses exist

(3) The transport problem. In most African countries road transport between the main cities is easy but transport to villages is difficult and slow.

(4) The language problem. Except in North Africa, few African countries have a national language which can be used for interviewing throughout the country. Moreover in most African countries one cannot find enumerators who are literate in African languages. In such countries the questionnaire has, in most surveys, been printed in English or French, the questions have been delivered in the local language, and the answers have been recorded in English or French. In some countries an African language such as Swahili of Amharic plays the role of English or French described above, but the translation problem may remain because a large proportion of the population cannot speak the language.

(5) Availability of field personnel. Apart from the language problem already mentioned, it is generally possible in Africa to find enough people of sufficient educational standing to act as enumerators and supervisors provided one is seeking male personnel. In many countries qualified female personnel would not be so readily available.

(6) Response. In most parts of Africa a successful approach to the population depends on getting the prior agreement of the local traditional authorities. Given time and tact this can usually be obtained and once this is done refusals by individual households are almost unknown.

(7) The household. The concept of a "household" only very roughly fits the African reality. (Despite this, and the resulting definitional difficulties, the household has been used as a reporting unit in almost every African survey.)

(8) Miscellaneous. In most parts of Africa most people do not know their age. Many other important concepts - such as marriage, employment, income- present special difficulties when an attempt is made to apply international standard concepts to African populations.

These are perhaps the main factors which should be borne in mind if it is desired to make use of this manual in a non-African context.

CHAPTER I

OBJECTIVES OF DEMOGRAPHIC SURVEYS

As mentioned in the Introduction, this is a manual of survey technology; it is taken for granted that the fundamental questions of survey motivation have already been settled and that the reader, by the time he comes to this manual, is concerned with the practical problems of implementing the survey. There is thus no discussion in the manual of the broad objectives of demographic surveys - the non-demographic purposes for which the demographic data are needed.

The first three chapters are mainly descriptive: their purpose is to give an account of the principal features and variants of the broad central class of demographic surveys with which the manual is concerned. The present chapter discusses survey "objectives" in the limited sense of the immediate statistical purposes of the survey.

The objectives of demographic surveys may be classified into four broad groups:

Estimation of total population and its geographical distribution;

Estimation of a variety of demographic characteristics of the existing population;

Estimation of the components of population change: fertility, mortality, migration;

Check on the population census.

Any one survey may have several of these objectives. We now discuss briefly each group in turn.

Estimation of total population and its geographical distribution

This objective is most usually the task of the population census. In developing countries a survey will have this purpose only if there is no adequate census. Note that, since the survey is based on a sample, it cannot hope to give a very detailed geographical breakdown of the population; this is one of the main reasons why a complete census is preferred to a survey when the means are available. A common type of survey in the present category is a survey carried out as a substitute for a census in a part of the country where a full census is not practicable (see Chapter 2).

Estimation of current demographic characteristics

The following are the characteristics of the population most frequently included for study:

Number and composition of households

Age structure

Marital status

Place of origin or birth

Ethnic classification

Language classification

Religious affiliation

Educational level

Economic characteristics

Housing

(Some specialists would not regard the last three as belonging strictly to "demography" but they are very frequently included in demographic surveys). Any of these topics may be studied either as an objective in its own right or for cross-tabulation with other characteristics such as fertility.

Estimation of components of population change

Almost any demographic survey worthy of the name will include among its objectives some attempt to estimate the rate of population change. There are many ways in which this may be done and these are discussed later. Nearly all the methods involve separate estimates of the components: fertility, mortality and migration.

Check on the population census

This is the "post-enumeration survey", discussed in the next chapter. Note that two types of check are possible: the coverage check and the content check. The coverage check tests to what extent the census successfully covered all places and all persons, once and once only; the content check aims to test how far the information collected in the census is correct.

Demographic survey as a by-product

A special case, but a fairly common one, is the demographic survey whose motivation (or finance) comes from a non-demographic objective, most often the need to provide a sampling frame for another survey. In most developing countries, at least in rural areas, no lists of households are available; as a result, surveys have to be conducted by selecting a sample of areas, listing all households in each chosen area, and then selecting a sample of households from the list. The listing operation has in several cases provided the opportunity for a demographic survey.

Fixing the objectives

It is of the greatest importance, before starting work on a survey, to fix clearly the survey's objectives. Every aspect of the survey depends on this decision.

The questionnaire depends on the objectives. Questions must be chosen to get the information which the survey needs.

The sample design depends on the objectives. Some demographic characteristics are clustered (i.e. neighbouring people tend to be alike). Characteristics which are more clustered need a less clustered sample, for a given precision. Stratification may also be affected by the objectives (see Chapter 7).

The sample size depends on the objectives. The more precision is needed, the larger the sample must be. Also, the more detailed the breakdowns needed, the larger the sample must be.

The cost depends on the objectives, since the cost depends on the sample size and design and on the organization of field work.

The timing of the survey depends on the objectives in many obvious ways. For example, a post-enumeration survey must not be long after the census. An inter-censal survey should be approximately half way between two censuses. The timing of multi-round surveys is crucial (see Chapter 11).

The organization of field work depends on the objectives since it depends on the sample design and timing, as well as on the amount of effort to be expended on quality control of operations which in turn depends on the precision required.

The data-processing is a direct reflection of the objectives: the immediate objective of every survey is to produce certain tables, and the ultimate objectives themselves define what tables are needed.

The objectives need to be fixed not just in broad terms but in detail. For example, the sample size and hence the cost depend crucially on the degree of detail required in the results: what cross-tabulations are needed, how much geographical breakdown, and so on. Further it has to be decided whether each variable is being included for its own interest or as a classifying variable - i.e. for cross-tabulation with other variables. As an example we may take educational level. If the survey aims to estimate the number of persons at a given educational level, the sample must be large enough to provide a sufficient number of people at each educational level of interest. (For a more exact meaning of "a sufficient number", see Chapter 8). But if we wish to examine how fertility varies with educational level, i.e. to cross-tabulate fertility and educational level, we shall need a sample large enough for estimation of fertility at each educational level. If the full educational classification is to be used, this will generally be a much larger sample. On the other hand, it is often the case that a variable tabulated for its own sake is required in a detailed classification, but when used for cross-tabulation it is required only in broad groups. (This is notably true of occupation.) This may therefore imply a smaller sample in the latter case. It is clear then that the use to be made of each variable should be considered at the planning stage of the survey.

It follows that planning of the survey must begin with the specifying of the objectives in some detail. How is this done? A common procedure which is not recommended is to start with the question: "What shall we put in the questionnaire?" In fact, the content of the questionnaire does not suffice to specify the objectives: it does not show which items will be cross-tabulated, how much geographical detail will be required, whether estimation of total

population is to be an objective, etc.. A better starting point is the list of tabulations required. These, together with some rough estimates of the sampling precision needed, determine all aspects of the survey.

To sum up, detailed planning of the survey should begin by drawing up a list of tabulations required. These tables translate the objectives of the survey into operational form.

One fundamental "objective" of a survey is its coverage. This will be discussed in Chapter 3.

Consultation in choosing the objectives

A demographic survey is an expensive operation. It cannot reasonably be regarded as the private property of its organizer, nor even as the property of the statistical office. Consultation at the planning stage with other bodies and experts should be considered an absolute obligation.

Such consultation has two aspects. Firstly, it is important to plan the survey in the context of existing knowledge. For example, if the rate of natural growth of the population is already known to within a margin of error of ± 0.4 per cent, there is little point in planning a survey whose margin of error is no smaller than this. Even more obviously, if a demographic survey is being conducted, or has recently been completed, by another organization in the country this may remove the justification for the planned survey - or at the very least there should be possibilities of large economies in the new survey. 1/

Secondly, some attempt should be made to accommodate the needs of potential users of the survey. This, again, requires consultation with government departments, universities and individual experts. On the other hand caution is needed to avoid overloading the questionnaire. Many surveys have suffered severely in quality through the attempt to cover too much in the interview. It should never be forgotten that every additional question means more complicated training and instructions, with an increased chance of defective work and inaccurate results. This being so, the main purpose of consulting potential users is to ensure that the proposed definitions, classifications and tabulations satisfy their requirements. Great caution should be exercised in adding questions in response to users' demands.

Some specialists have advocated a type of "cost-benefit" approach to choice of topics: the survey planner attemps to balance the costs and gains of including each suggested additional topic. However, the gain from a piece of statistical information is extremely hard to quantify as is the cost in terms of the damage done to the quality of the other data collected. Thus this approach has not generally found much favour in developing countries.

1/ In one African country two demographic surveys were recently carried out simultaneously by a government department and a university and a third had been completed a year earlier by another group within the same university. The three groups acted in complete independence without consultation; some of the definitions of important concepts were incompatible. This country has since set-up a co-ordinating committee which should effectively prevent such wasteful use of resources in the future.

A demographic survey may supply a useful household sampling frame for other kinds of surveys and its value for this purpose may be much increased if (1) the time interval between the two surveys is short and (2) the demographic survey collects information which can be used for stratification. In most cases these requirements can be met without any important modification in the plans for the demographic survey. They do, however, imply advance coordination with the body responsible for the subsequent survey (for example, the Ministry of Agriculture). This is another reason for ensuring wide discussion of the proposals for the demographic survey at the planning stage.

CHAPTER 2

RELATIONSHIP TO THE POPULATION CENSUS

Demographic surveys may be related to the population census in many different ways. The purpose of this chapter is to list and describe these relationships so that the background will be clear when detailed problems are discussed in later chapters. The emphasis will be on the possible technical relationships that may exist between a survey and the population census, rather than on the relation between their objectives.

Demographic survey as part of a census

There are three main possibilities: (1) Sample enumeration in a limited area, (2) The "built-in sample", (3) The "post-enumeration survey". These will be discussed in turn.

(1) Sample enumeration in a limited area

In a part of the country where enumeration is difficult, or where good enumerators are hard to recruit, it may be decided to carry out the census enumeration on a sampling basis. In Africa this procedure has been used only for nomadic areas.

(2) Built-in sample (BIS)

In many African countries a complete census has been carried out in the whole country but additional questions have been asked in a sample of areas. This is the "built-in" or "concurrent" sample. The essential feature is that a simplified questionnaire is used in the main census and a more detailed questionnaire in the sample. The purposes are: (a) to simplify the training of enumerators - only a fraction of them have to be trained with the long questionnaire and these can be selected as the most important; and (b) to reduce the total time spent on field work.

The advantage (a) operates only if some enumerators work entirely with the short questionnaire, others entirely with the long. Since each enumerator covers a definite area exhaustively, this implies an area sample - for example, one area in every 10 may be selected for the long questionnaire.

An alternative sampling plan, namely having every enumerator use the long questionnaire in every n^{th} household visited, is used in some developed countries. If operated correctly this method produces a more efficient sample; however, its validity relies on the enumerator sticking closely to his instructions regarding sampling. He must not, for example, select for the longer questionnaire households which are easier to interview, or households which seem more "typical". In addition, the household-sampling method misses the advantage (a) above, namely saving in enumerator training.

As for advantage (b) - reduction in the total load of field work by eliminating a number of questions for a large part of the population - the saving from this is not necessarily very large. Although information on the detailed breakdown of census field costs is lacking, it seems likely that,

in a developing and largely rural country, less than half of the total census field cost is attributable to the time spent by enumerators in asking such questions and recording the answers 1/, while the field cost itself accounts for much less than half of the total census costs. It is probably more important to consider the saving in training and the possibility of selecting the best enumerators for the larger questionnaire.

In selecting items for inclusion in the long questionnaire, one will choose those for which a very detailed geographical breakdown is not required and those which are more difficult to handle at the interview. 2/ Questions on fertility and mortality typically satisfy these conditions and qualify for the long (sample) questionnaire. It is tempting to relegate to the sample those questions which seem "less important", but this is not a rational procedure. In general, the sample should give results which are more reliable than the main (short) questionnaire, among other reasons because the sample enumerators have been selected as more competent.

(3) Post-enumeration survey (PES)

The post-enumeration survey (PES) checks the census by means of an independent enquiry carried out after an interval. It may be used to check either the census coverage, or the reliability of the responses on individual census items ("content check"), or both. In order to check coverage, it should be based on a sample of census enumeration areas; the time interval between the census and the survey should be short - a few weeks; and the survey should operate completely independently of the census.

The full potentiality of the PES as a check on the census is only realized if the PES data are matched, person-to-person, with the census results. In African countries such matching is generally extremely laborious and often has to be limited to a subsample.

Choice between built-in sample and post-enumeration survey

In principle, the basic purpose of the built-in sample (BIS) method is to collect additional data, and the basic purpose of the PES is to check the census. But in fact each of these operations also fulfills the other purpose to some extent.

1/ Processing costs do not need to be considered in this argument. If one is willing to economize by sampling, one can equally collect exhaustive data and sample at the processing stage. The cost saving attributable to the method of the "built-in-sample" is essentially the additional field work involved in interviewing all persons with all questions.

2/ One should also consider the clustering effect. Since the long questionnaire will be used in a cluster sample, it is particularly unsuited for characteristics which are highly clustered in their distribution among the population. Such characteristics will be subject to a specially high samplin error. (See Chapter 7)

The BIS provides a check. The built-in sample being a probability sample, it should give results which agree with the main census within sampling error limits. This is a statistical check, which is of course less powerful than the matching check of the PES - in other words, the BIS check will not reveal any cancelling errors but only net error.

The PES provides additional data. The PES normally fulfills exactly the same function as the BIS in providing additional data (long questionnaire) on a sample basis.

Three objections are sometimes raised against the PES as a check. (1) Person-to-person matching is so cumbersome that in practice it is of little value. This criticism relates to the content check; it leaves untouched the value of the PES as a coverage check. (2) If the check of the PES results against the census reveals a discrepancy, a third operation is needed: a reconciliation survey. Otherwise we still will not know whether the error is in the census or the PES. (3) In practice it is difficult to ensure that the PES is really carried out independently of the census. Even if a different enumerator is used he will still have to rely on the guidance of the same chiefs and headmen; thus errors of coverage in the census may well be repeated in the PES.

These objections are serious but not necessarily over-riding. As already mentioned, the person-to-person matching can be restricted to a subsample, and the reconciliation operation to the same subsample. Objection (3) is valid to some degree but would not normally vitiate the PES check completely.

In developed countries it is assumed that the PES will give more reliabl information than the census, because the smaller scale of the PES allows the selection of better enumerators and more thorough training. This is less certain in Africa. In the first place, selection of the better field workers for the PES presents several problems. The better enumerators are more likely to come from outside the area in which they will have to work; there is then more chance of a language difficulty and they may be less readily accepted by the people. In practice the best enumerators may not be available for the PES since they would generally be employed in other jobs, and although their employers may be prepared to release them for the main census they may be unwilling to do so for the longer period of the PES. Apart from the question of field personnel, the short duration of the general census and the national publicity which accompanies it leads to widespread enthusiasm; to a large extent the people themselves ensure that everyone is enumerated. The PES which follows is carried out in an atmosphere of waning interest and must appear unjustifiable to much of the population.

A further advantage of the BIS is that it does not involve re-interview of households which have already been enumerated and this removes one cause of irritation for the population. By the same token, the BIS involves a smaller total number of interviews than the PES (even without considering the reconciliation operation for the latter). These advantages are, of course, simply the counterpart of the essential disadvantage of the BIS; that because there is no re-interview it does not provide a true check.

Whether or not these arguments are considered decisive, it is clear at least that the PES requires two complex field operations (the PES itself followed by the reconciliation) at a time when the census office is pre-occupied with handling the mass of data arriving from the main census and attempting to produce some preliminary results as rapidly as possible. A country with a limited office or managerial capability may well judge that in these circumstances the BIS provides a more manageable option than the PES. Some African countries have nevertheless opted for a PES in full awareness of the difficulties mentioned. Until their experience has been more fully analyzed, it would not be justifiable to give a firm recommendation on this issue.

We now turn to an examination of the various other ways in which a demographic survey may be related to the population census.

The census as a sampling frame for demographic surveys

Before a census is taken it is necessary, or at least very desirable, to divide the country into well defined small areas each corresponding to the work of one enumerator. These are termed enumeration areas, or EAs. In Africa, EAs have been typically of about 500-1000 population. These units serve as a convenient area sampling frame for all kinds of surveys.

For surveys conducted simultaneously with, or very shortly after, the census, a sample of area units may be selected with equal probability. Where the survey comes at a longer interval after the census, so that there has been time to obtain the individual EA census population figures, another advantage of EAs as sampling units appears: the census population of the EAs can now be used as supplementary information to reduce the sampling error of the survey. The information can be used either at the sampling stage (sampling with probability proportional to size) or at the estimation stage (rati estimation or re-weighting the sample). For fuller details see Chapter 8.

The population census cannot normally in Africa provide a usable samplin frame of households, because of the lack of any reliable system of addresses. Several attemps to use the census in this way in African countries have proved unsuccessful.

Other relationships between the census and a demographic survey

Other relationships are implicit in the preceding discussion but may be worth making explicit here.

The census may provide the organization for the survey. This is implicit in the BIS proposal, and in practice the same has been true of the PES: up to now in Africa every PES has been conducted by the country's census organization. However, a convincing case can be argued for an alternative policy: to contract out the PES to a separate organization, thus ensuring greater independence and hence a more effective check.

Apart from specially designed checking operations, such as the PES, any demographic survey can be usefully cross-checked against the census. If, for example, the survey populations of EAs turn out consistently smaller than the census populations, this suggests under-enumeration in the survey and the discrepancy should be investigated by intensive field work on a sub-sample. Survey data should always be checked against existing data (whether from the census or from other sources) and discrepancies followed up.

In general one might reasonably expect a survey to yield more accurate data than a census. However, this may not be so as regards coverage. The census has two advantages in this respect. Firstly, the publicity attending a census helps to ensure complete coverage: the people themselves will make sure they are not omitted. Secondly, the fact that the census is exhaustive simplifies the demarcation problem: the enumerator who strays outside his area will necessarily be entering the area allocated to another enumerator. There is then a good chance that the mistake will be brought to light, either by the neighbouring enumerator or by the people who are enumerated twice. Despite these advantages of the census there is a corresponding disadvantage, namely that the publicity and the political importance attaching to a census may encourage attemps to inflate the enumeration. All these considerations should be taken into account when census and survey data are checked one against the other.

Demographic survey as a substitute for a census

We have already considered the case of the demographic survey which is used in place of a complete enumeration in a limited area, in the context of a national census. A much more common case is the demographic survey which is carried out as a substitute for a census in a country where a satisfactory census is considered impracticable or too costly to be justified. Such a survey may be national in coverage or, if conditions are particularly difficult, it may be limited to the part of the country where it is estimated that it can be conducted successfully. (For example in the case of Kinshasa 1967-1968, such a survey was limited to the capital city.) When the coverage is limited in this way, the remainder of the country will have neither a census or a survey.

Demographic surveys have been used essentially as a substitute for a census in nearly all of the French-speaking African countries South of the Sahara. In most of these countries the only "censuses" which had ever been attempted up to 1973 were the regular administrative counts (recensements administratifs) carried out by local administrations for taxation purposes.1/ The efficiency of these counts has varied widely in different areas; in most countries there has not even been a uniform list of items of information to be covered. As a result, demographers have ignored the administrative counts and practically the only source of demographic statistics for these countries has been demographic surveys, organized as separate operations.

1/ Notable exceptions were the censuses in Togo (1960, 1970) and Gabon (1970). In some other cases there have been serious demographic censuses, on an exhaustive basis, of the one or two largest cities.

The administrative counts, though generally unreliable, have nevertheless served one of the purposes of a census quite adequately: they have provided a list of villages, with rough population figures for each village, which acts as a convenient sampling frame for surveys. In particular, the demographic surveys in these countries have been based on this sampling frame using the "administrative population" of each village as supplementary information, in the manner outlined above.

The inter-censal survey

It is sometimes argued that 10 years is too long a period to leave between population censuses: important parameters may change in a period shorter than this and some attempt should be made to pin-point them at the half-way mark. The argument is strengthened by the long delays in processing to which censuses are commonly subject. If, for example, results take 4 year to appear, then census users are obliged to work with data which may be up to 14 years old. This is the rationale of the inter-censal survey: a sampling operation designed to provide interim information on some of the population parameters at a time approximately mid-way between censuses.

CHAPTER 3

COVERAGE AND METHOD

In this chapter we consider firstly the question of coverage in space and in time and secondly the main lines of the methods used in demographic surveys. Detailed questions of method are treated in later chapters.

Coverage: (I) Surveys conducted as part of a census

When a survey is an integral part of the census, its coverage has to be decided in the light of the survey's purpose in the context of the whole census operation. For the three cases denoted (1), (2) and (3) in Chapter 2, the position is as follows:

(1) Sample enumeration in a limited area. The coverage will be the area of country where conditions for enumeration are particularly difficult, typically nomadic areas. See note on nomads at the end of this chapter.

(2) Built-in sample. A typical arrangement is to use the built-in sample method in rural areas only. In urban areas the enumeration will then be exhaustive, but with the long questionnaire.

(3) Post-enumeration survey. Since the basic purpose is to check the census, the sample is normally arranged to cover the whole country.

Coverage: (II) Demographic surveys which are not part of the census

Surveys in this category include: inter-censal surveys, surveys carried out as a substitute for a census, most vital rate surveys, and demographic surveys carried out as a by-product of another survey. These are in no way mutually exclusive categories: in particular, the category "vital rate surveys" may overlap with any of the others.

Most of the demographic surveys which have been conducted in Africa have covered one entire country. However, those carried out as a by-product - generally in course of the household listing stage of an agricultural or household budget survey - have more often been limited to one region within the country or to one city.

There is no doubt that most users of demographic survey data wish to have information for the whole country. Where coverage is incomplete, users often have to make their own extrapolation. In practice they are likely to assume that the main demographic features of the area covered extend also to the area not covered. Full national coverage should therefore be considered a highly desirable objective for a demographic survey. Despite this general principle, however, cases will arise in which the inclusion of remote areas is impractical or too expensive to be justifiable. If the population in question is less than 5 per cent of the national total it is unreasonable to go to great lengths to include them.

A few countries have carried out regional surveys successively, with ultimate coverage of all or nearly all the national territory when the regional surveys are put together. The reduced scale of operations at any given time makes supervision easier and should improve the quality of the data. On the other hand, the staggered timing creates difficulties for the user, particularly if there is significant migration between areas covered at different times (as for example when the urban and rural sectors are covered at separate times). Whether the organizational advantage outweighs the inconvenience to the user can only be decided in each individual case.

Single round versus multi-round survey

The majority of demographic surveys in Africa have been single round surveys - that is to say, the enumerator makes one visit only to each household. As far as determining the current structure of the population is concerned, such an arrangement is perfectly satisfactory.

However, many important demographic parameters are measured as rates (e.g. births, deaths, migration), and these necessarily refer to a definite period of time, namely one year. For single round surveys the period of reference is in most cases taken as the 12-month period ending at the moment of the interview. Thus, such surveys typically ask for a report of births and deaths occurring in the household "during the last 12 months". However, it has been often shown that vital events are not accurately reported when single round surveys are used with retrospective questions of this kind. The method has been found to lead to both errors of omission and errors of dating An overall error (gross error) close to 20 per cent for births and 40 per cent for deaths has been reported by two developing countries independently (Morocco and India). 1/

The multi-round survey is an attempt to overcome some of the sources of error inherent in the single round approach, as regards the estimation of births, deaths and migration. Basically, the idea is to carry out a first round in which the enumerator prepares a list of persons to be surveyed (selected as a probability sample) and then to visit the same sample after an interval in order to record the changes that have occurred. Further visits may follow at appropriate intervals, so that the sample of households then becomes a sort of vital rate "panel".

It is obvious that this method, though more expensive, should reduce errors of both omission and dating. However, it does not solve all the problems. In particular, infants who are born and die between the rounds can still be detected only by the retrospective approach, and there are difficulties in detecting events associated with persons who leave the sample area between rounds. The special problems of such follow-up surveys are treated in Chapter 11 of this manual.

1/ Some more detailed figures, broadly in line with the above, are given in Demographic data collection: A summary of experience, by W. Seltzer, Population Council, 1973.

Since three or four rounds are needed altogether (see Chapter 11), with a sample size of approximately 100,000 at each round (Chapter 7), it will be appreciated that a multi-round survey is an expensive operation.

The relevance of the multi-round method may be summarized as follows:

(1) A single round suffices, in principle, to provide the current population picture - that is, the total population and its present characteristics.

(2) For estimating population change, however, observations must be made relating to a period of time. There are a number of alternative approaches to this which will be considered in later chapters (including, for example, comparison between consecutive censuses, retrospective questions at a single round survey, etc.).

(3) The multi-round follow-up survey is one of the methods designed to improve the estimation of the components of population change.

(4) The first round (or any one round) of a multi-round survey would, of course, serve the objectives of any single round survey. If some of these objectives (for example, estimation of total population) required a more detailed geographical breakdown than the components of change, this might be met by using a large sample at the first round and a subsample for the follow-up rounds.

Later in this chapter we describe some other methods designed to collect more reliable data on the components of population change.

The question of the choice between these various methods arises only if estimation of population change is one of the objectives (because otherwise the single round survey suffices). 1/

Note on terminology

Multi-round surveys in which the same sample is interviewed repeatedly have been variously termed follow-up surveys, continuous observation surveys, repeated observation surveys, longitudinal surveys, and the household accounting technique. Different shades of meaning have been attached to these terms at various times. However, there is no agreed terminology and it does not seem profitable to attempt to establish one in this manual. (We do, however, suggest below a clear distinction between a multi-round survey and a vital registration operation.)

Time coverage of a survey: fixed or indefinite

Many multi-round surveys are designed as one-shot operations to be carried out over a period of one year. There is, however, no reason in

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1/ It should be admitted here that this argument is over-simplified. There is evidence of better coverage and reporting in the later rounds of multi-round surveys. But the cost of the additional rounds is such that they could hardly be introduced on these grounds alone.

theory why they should not continue indefinitely, providing current data every year on vital rates, like a vital registration system.

This distinction, between a survey for which a definite time limit is fixed at the start and one which is intended to continue indefinitely, may perhaps appear artificial since such decisions can be changed at any time. However, the distinction is important in relations to sampling in time, in more than one way:

(1) If the survey is to continue over a long period, then clearly the sample in any one year can be smaller, provided we are content to estimate the average values of the vital rates over several years (which also means: provided we are willing to wait several years for a statistically reliable result).

(2) If the survey is to be completed in one year, then that year will have to stand as an estimate for all subsequent years until the next enquiry. Whether this is a reasonable procedure depends on the natural variation of the vital rates from year to year.

(3) Further, for a single-year survey, there is obviously no point in reducing the sampling error to a level much below that of the random variation between years.

Thus, a rational decision on sample size for vital rate surveys requires a decision at the same time on the period to be covered by the survey.

It will also be seen from the above that these decisions require an estimate of the natural variation of vital rates from year to year. Some evidence on this is discussed in Chapter 7.

Vital registration on a sample basis

In developed countries, information on vital events comes mainly from civil registration. In African countries registration is almost everywhere defective and cannot be used directly for serious demographic purposes. It has often been suggested, however, that a civil registration scheme might be set up effectively in a developing country if it were limited to a sample of registration areas. Special efforts could be made in the sample areas which would not be practicable if the whole country were covered.

This idea is clearly similar to that of the continuous observation survey of unlimited duration mentioned above. While once again there is no agreed terminology, it is convenient to distinguish sharply between sample vital registration and a survey on the following basis:

In a registration system, only the vital events are recorded.

In a survey, a questionnaire is completed for every sample household.

The above distinction is important because it means that, in a registration system, special arrangements have to be made to determine the base population (i.e. the denominator of the vital rates) and bringing it up to date from time to time.

In practice, this requirement implies that any sample registration system must be accompanied by a survey (or at least, must be extended so that it effectively becomes a survey). The registration provides the numerators of the vital rates and the survey the denominator. The survey will have to be repeated from time to time to keep the base population estimate up to date.

A regularly repeated survey is itself, of course, a good means of estimating vital events. Since, in any sample registration system, such a repeated survey will be necessary, why not use it to obtain an independent estimate of the numerator? This reasoning leads to a concept which has been widely applied in Asia (Pakistan, Thailand, Turkey, India) and which made its first appearance in Africa in 1968-1969 (Madagascar, Liberia): the combined registration-survey method, sometimes termed the "PGE" method, after the original "Population Growth Estimation" project in Pakistan. In this manual we refer to it as the dual record system.

Dual record system (PGE)

The system is based on the collection of data from the same sample by two independent operations:

Registration. A local inhabitant is nominated registrar in each sample area. In many cases he is assisted by sub-registrars, each of whom is responsible for reporting all vital events in a small part of the area. Reports, including null returns, must be made monthly by every registrar and sub-registrar.

Survey. A multi-round survey is made of the same area at fixed intervals, generally every 3 or 6 months, using enumerators who operate independently of the registrars.

The results of the two operations are matched, event by event. In case of discrepancy, a further visit may be made to the household concerned. In many cases the survey also provides the denominator for the rates. The system is generally set up to continue indefinitely, in a fixed sample of areas. The method is described in more detail in Chapter 11.

The principle on which the system is based is that two independent operations are less likely to miss an event than one. It is essential, however, that the two operations be truly independent. If the registrars collaborate with the enumerators, most of the advantage of the double system is lost.

The dual record system is generally even more expensive than the follow-up survey. Moreover, the matching operation is complex and laborious. Yet, when working at its best, there is probably no more accurate method of collecting data on vital events in a developing country. The choice between methods that are cheaper and simpler but less accurate and those that are more expensive and complex but in principle more reliable, is a difficult one. For further discussions on this problem, see Chapters 11 and 12.

A note on migration

Among the three components of population change, births, deaths and migration, the first two are relatively stable in their incidence; a variety of analytical techniques are available which enable demographers to project their effects on population change with reasonable confidence several years ahead. The situation is different with the third component, migration.

Migration rates are influenced by many factors: economic motives at both ends ("push" and "pull" factors), political decisions, civil disturbance and many other influences. Most of the factors are quite unpredictable and may suddenly and unexpectedly change the magnitude and even the direction of migration. Moreover in some of the smaller African countries migration may outweigh natural population growth as a source of population change. As long as this situation persists, refined techniques for projecting the natural growth of small areas (whether small countries or regions within larger countries) can have little significance.

On the other hand there are signs in many parts of Africa of increasing control and limitation of external migration by governments. Moreover the net effect of migration over a group of neighbouring countries must tend to cancel out. Thus population projections may be expected to become increasingly meaningful and particularly so where they cover large areas.

Migration takes many forms and it is important to distinguish these when planning a survey. First a classification may be made in terms of the extent of the movement involved:

(1) External migration: movement across national frontiers

(2) Internal migration: movement within national frontiers, of which the following types may be distinguished:

  (a) Regional migration: movement between regions within the country.

  (b) Rural-urban migration.

  (c) Local mobility: movement from one dwelling to another in the same locality. (Such short-distance movements are often considered to be excluded from the term "migration". We include them for convenience).

Secondly, distinction may be made in terms of the frequency of movement. Thus we distinguish nomadism, seasonal migration (including tourism), and migration for more or less permanent settlement.

Each of these types of movement may be of concern in any of several ways:

(i) The movement itself may be of interest: net immigration is one of the components of population growth.

(ii) Migration may be of concern for its bearing on the structure of the population. For example, a country may want to know how many persons of foreign origin are resident within its frontiers.

(iii) Migration is often an important economic factor. Examples:

Emigrants may remit money from abroad

Seasonal immigrants may make an important contribution to bringing in the harvest

Movement into urban areas may contribute to unemployment

The "brain drain" may deprive a country of educated manpower

Tourists may bring in foreign exchange.

(iv) Finally, migration is relevant in a special way to the problems treated in this manual, because a high rate of population mobility is a complicating factor in the execution of demographic surveys. There are two main reasons for this:

Follow-up surveys become less effective if a substantial proportion of persons interviewed at one round have moved before the next round.

In a more mobile population the difference between the de jure and de facto population is larger and the former depends more crucially on the exact definition of residence.

A special case is that of nomadism. Clearly, nomadic populations require an altogether different survey approach from that used for settled populations This needs separate discussion.

Surveying nomads

Although a good deal of experience has been gained on the surveying of nomads in Africa it cannot be said that any satisfactory solution has been found.

Three methods have been tried for obtaining a valid sample.

(1) Sample of water holes. If the survey has been carried out in the driest season one should find the population clustered around the water holes. Assuming the location of the water holes is known to the authorities it should be possible to list them and select a sample. In practice it has proved extremely difficult to obtain complete and up-to-date lists: the water holes shift from year to year and sometimes disappear altogether. Moreover, the people do not stay out around the hole to suit the enumerator. Finally, the number of people varies widely from one hole to another and is not known in advance, so that planning of the work is difficult.

(2) Aerial survey. Attempts to count nomads by air date back to the '40 The usual procedure is to count the tents or huts seen from the air, then to send field workers to find out the average population per tent. Obviously, the latter involves the same sampling problem as any other method (any attempt to select from aerial photographs a sample of tents, or even clusters of tents, for interviewers to visit is quite impracticable). Thus, the mere fact of aerial survey does nothing to solve the basic problem, which is one of sampling.

(3) Sampling based on social and kinship structures. The only approach which has met with some degree of success has been that of working through the existing tribal structures. In all nomadic populations there is a hierarchy of tribes, clans, families, etc., one under the other, and at each level the chief should know the location of the people under him. In theory therefore, it should be possible to make a sampling frame for each level, dow to the family. Obviously the practical difficulties are serious: for example the selected households may be far distant from one another, or they may be difficult to trace despite the chief's directions. Good results cannot be expected in all areas but by and large this method appears to have worked better than any others.

Throughout the rest of this manual it will be assumed that the populatio to be surveyed is sedentary.

Summary on coverage and methods

(1) Except for special cases, coverage should be national.

(2) Three main types of sample demographic operation have been used in developing countries:

(a) The single round survey
(b) The multi-round follow-up survey
(c) The dual record system (PGE)

(3) Method (a) is satisfactory:

For estimation of total population and its geographical distribution

For determination of the current structure of the population

For checking of the census.

(4) However, if population change is to be estimated, then methods (b) and (c) become relevant and a choice therefore has to be made between (a), (b) and (c).

(5) The three methods have been listed in (2) above in order of increas ing cost and complexity. Decision between them depends on consider ations that have not all yet been discussed in this manual. The problem is therefore deferred until Chapter 12.

(6) If (b) or (c) is chosen then the objectives listed under (3) above can be covered by the first round of the survey. If necessary the later rounds could be limited to a subsample of the first round sample.

(7) If (b) or (c) is chosen, then for efficient planning of the survey it is necessary to decide whether the operation is to last for a definite period or to continue indefinitely. In taking this decisi some estimate of the natural variation in vital rates from year to year will be needed.

CHAPTER 4

BASIS OF ENUMERATION

Survey objectives have already been discussed in chapter 1. In this chapter and the next we assume that the broad objectives have been fixed and we examine more closely what information has to be obtained in order to meet these objectives. Many of the problems examined in this connexion are essentially no different in surveys and in censuses; examples will therefore be quoted from either type of operation.

The present chapter deals with two important questions affecting the whole framework of the enquiry: the basis of enumeration and the definition of a household.

4.1 DE FACTO OR DE JURE ENUMERATION

The question whether to use de facto or de jure enumeration is a problem which often consumes many hours of discussion when a demographic survey is being planned. There are many arguments on both sides and the best solution will depend on the features of the survey, on the use that is to be made of the data, and perhaps on the characteristics of the population studied. Inevitably, therefore, the discussion which follows is complex and does not lead to any clear-cut recommendation. The reader may prefer to skip to the summary at the end of this section.

First, the basis of enumeration has to be considered separately for enumeration of the population and enumeration of vital events.

Enumeration of the base population

In censuses and demographic surveys which have been conducted both in Africa and in other parts of the world, two different approaches have commonly been used: the de facto basis, which aims to obtain particulars of all persons who were in the dwelling at a specified time, whether or not they normally lived there; and the de jure basis, which aims to obtain particulars of the usual residents, whether or not they were present at the moment of reference.

REMINDER

De facto = Present at time of reference

De jure = Resident, whether present or absent at time of reference.

It is of course possible to enumerate both the de facto and the de jure population at the same time, and to sort out the needed population at the analysis stage. Thus one should distinguish the basis of enumeration and the basis of analysis, and the former can be de facto or de jure or comprehensive (both). What are the exact procedures of enumeration in each case?

(a) De facto enumeration

When this approach is used, the enumerators are generally instructed to record the particulars of all persons who slept in the dwelling on a specified night. In the case of censuses and surveys in which the enumeration is completed fairly quickly, a particular calendar date is often specified: e.g. in the 1970 census of Ghana, the night of Sunday 1 March 1970 was designated as "Census Night". But when the enumeration is spread over a longer period, as is normally the case with sample surveys, this procedure becomes impracticable, since people cannot remember who slept in the dwelling on a night which may be several weeks, or even months, before the enumerator comes round. In these circumstances the "Survey Night" has to be fixed in terms of the interview date - which means that it is variable from one household to another.

The method most commonly used is to instruct the enumerator to enumerate all persons who slept in the dwelling on the night before his visit. This procedure involves a small statistical bias. Enumerators who find a person or household temporarily absent are normally expected to call back for the interview when they return; if this is done, almost everyone will be found "present on the night before the interview" and there will be an upward bias. One solution is to fix the reference night in terms of some such formula as "The Sunday before the interview". This was done in the Ghana Population Survey of 1966.

However, it seems likely that this bias can be safely ignored, provided enumerators are moving fairly rapidly through the area so that they are not saving up call-backs over periods of weeks.

Where de facto enumeration is used, certain exceptions to the rules often have to be made. Two of the most important are the following:

Exception (1): Enumerators are told to include persons normally belonging to the household who were away from home on the reference night, being elsewhere in the country but in some place where they could not have been enumerated (e.g. out fishing or hunting all night).

Exception (2): In countries with heavy labour emigration, special provision is often made to include members of the household who are outside the country on the reference night. This procedure is generally limited to persons who (a) have been absent for less than a specified period (e.g. 4 years), (b) keep in touch by sending money or letters, and (c) are expected to return. Such persons are often enumerated in a separate part of the questionnaire, such as a box at the foot, and only limited particulars are recorded for them (e.g. name, sex and age). In the processing and analysis they are kept quite separate from the rest of the population.

(b) De jure enumeration

When this approach is used a clear definition of "residence" is required. Such a definition has two aspects: the conditions for membership of the household and the conditions for residence in terms of duration of stay. The former will be considered later in the section "Definition of Household". We consider here the duration of stay.

One possible approach is to fix a definite qualifying period for residence. If a person has been living in the household for more than a specified length of time, he ceases to be a visitor and becomes a normal member of the household; conversely, if a person has been absent for more than a certain period, he is considered to be living somewhere else. To avoid bias, the two qualifying periods should be the same. How long a period should be allowed?

The United Nations recommendation is 6 months - that is, 6 months continuous presence is needed to qualify for residence and 6 months continuous absence is the condition for non-residence. This implies that statistically the change of residence is regarded as occurring 6 months after the person actually moves. In theory, at the moment at which a person ceases to be eligible for enumeration in one place he becomes eligible in the other, so that each person is covered once and once only.

However, three difficulties now arise. (1) A person who moves for a second time within 6 months will not be covered at all for a certain period. (2) What exactly is meant by "continuous" periods of presence or absence? What limits should be set on brief interruptions of these periods? (3) The method involves asking for particulars of persons who are not present; obviously it would be better if we could interview such people at the other end - the place to which they have moved. If the qualifying period is reduced, these problems are made easier. However, the shorter the period the more we tend to come into conflict with the way in which the people themselves conceive of "residence". This requires some further discussion.

In most parts of Africa the population is highly mobile in the sense that members of a household frequently go away for limited periods and then return. For example, men go away to seek work; women go to their mother's house to have a baby; children go away to school; there is a constant movement in both directions between town and country. The household left behind will normally claim the absentee as a member as long as they expect him to return. For them, duration hardly enters as a criterion of residence, but in so far as it does only a very long duration can carry much weight. A person who had formerly established residence over many years or by ties of marriage cannot, they feel, reasonably be excluded simply on the grounds of a few months' temporary absence. Experience all over the world has shown that when the interviewer is using concepts which disagree fundamentally with those of the person interviewed, errors, misunderstandings and bias tend to be common. This, then, is a valid argument against basing residence on a very short period.

On the other hand, there are cases where a person or household has definitely and permanently moved and everyone knows it, yet the move is so recent that the enumerator, following the rules, has to refuse to accept the new

residence. Once again, this puts the enumerator at loggerheads with the respondent and a false response may be recorded. Because of this, in some surveys the respondent's intention has been taken into account. If he says that he intends to stay for 6 months, even if he has not yet done so, he is counted as a resident. This has the added avantage that we are more often collecting particulars from the place where the respondent is now, and less often from the place which he has left. But intention is an uncertain matter and it is arguable that we should not base statistics on anything so subjective. Moreover, for the statistics to balance we have to introduce a similar rule which excludes an absent person if he intends to stay away for more than 6 months. Of course, such a person is not there to tell us his intention. It is difficult enough to be certain of intentions when the person is present for interview; how much more uncertain, then, if he is absent. On the whole it seems simpler to avoid using intention as a criterion.

There is a fairly simple way of avoiding the problem of brief absences and at the same time settling the problem of the non-coverage of people who move twice. We simply define a person's residence as the place he has lived in most during the last 12 months. In the case of a single move this will give the same result as the 6-month qualifying period for residence and in the case of multiple moves it gives a simple criterion. This solution is recommended.

How is this definition applied in practice? The best procedure seems to be to put the question direct to the informant:

"In what dwelling have you lived most (or longest) during the last 12 months?" 1/

Of course the respondent cannot be expected to calculate the answer exactly in difficult cases and some errors must be expected. However the question ha several advantages: it is conceptually complete, it conforms with the United Nations definition in the case where the latter is complete, and it provides the enumerator with a simple and clear instruction relatively free of complicating reservations.

It will be seen that the choice of any particular period in defining residence is difficult. The choice of a 6-month qualifying period, or the longest residence within 12 months, is arbritrary and should not be taken as a firm rule for all surveys. In particular where temporary absences are less common a shorter period might well be preferable, and at the other extreme there is always the option of fixing a separate and much longer period for the special case of persons absent outside the country (see below).

1/ This is quite the same as "In what dwelling have you lived for most of the last 12 months?" There may sometimes be difficulty in translating this nuance, but the practical importance of this is likely to be small.

Assuming now that the definitions have been agreed, the enumerator's task is to list all residents and obtain their particulars. Assuming that enumeration is to be de jure, normally a column is added to the questionnaire for indicating "Present" or "Absent" (enter P or A); non-residents are not recorded at all.

When enumerating the absentees, countries often like to distinguish those who are elsewhere in the country from those who are outside the country and sometimes different criteria are used to define the two categories. Thus in the 1966 census of Algeria, persons recorded as "RAA" (Résident absent en Algérie) were defined as those who were absent elsewhere in Algeria and who had been away from home for not more than 6 months. On the other hand those to be shown as "RAE" (Résident absent à l'étranger) were to include all persons outside the country, irrespective of how long they had been away.

(c) Comprehensive enumeration

This necessarily involves asking both questions: who was present on the reference night, and who is resident? All such persons are listed and a column is included in the questionnaire to indicate "Present resident", "Absent resident" or "Visitor" (PR, AR or V). Again, absent residents may be subdivided into absent in the country and absent abroad.

Choice between the three methods

Any organization planning a census or demographic survey must decide at an early stage which of the three approaches should be adopted. In taking this decision one has to consider (a) the ease of operating the method, (b) the likely accuracy of the data obtained, (c) the needs of the user, and (d) compatibility with other definitions and operations. We consider each of these in turn.

(a) Ease of operation

The de facto method is an attractively simple conception. The idea of merely recording all persons present at a given moment is clear and straightforward. It is true that, as we have seen, this normally needs some modification: provision has to be made for a moving reference night and for the enumeration of persons who did not sleep in any residence. But the practical difficulties of defining "residence" in the de jure method appear greater. As for the comprehensive method, this involves the enumerator learning how to handle the problems of both of the other methods and is therefore still more difficult.

(b) Likely accuracy

Simplicity favours accuracy, so that the arguments just given favour the de facto method. However there are other considerations on both sides.

The de facto method corresponds less closely to the way of thinking of the respondents and this conflict of approach easily leads to misunderstanding and distortion of response. Very early in a survey interview, or even before it starts, the respondent typically forms a definite idea of what is wanted

of him; if this idea is wrong it takes a well trained interviewer to put him right. In African demographic surveys the head of the household is likely to assume that he is being asked to list the members of his household, and by "household" he means something even more inclusive as regards absent relatives than the demographer's "de jure household", and strictly exclusive of visitors. If information is to be sought on the de facto population a quite specific question will have to be asked about visitors. The success of the de facto enumeration therefore depends on having well trained and conscientious enumerators. This is one reason why de jure enumeration has been favoured in many surveys.

In the de jure method, if the scope is nationwide the number of absent residents should approximately equal the number of visitors. If the comprehensive method is used, this can be checked, which is informative - although it has to be admitted that if the check reveals a discrepancy there is no method of correcting it. When such checks have been run, the number of absent residents has often been found much higher than the number of visitors. In the 1966 census of Algeria, 483 000 persons were recorded as absent (within the country) and only 256 000 as visitors. The suspicion can hardly be avoided that some persons were recorded as absent residents in one place and as present resident in another. Such double counting is believed to be a common feature with de jure method.

A further defect of the de jure approach is the difficulty in obtaining accurate information about persons who are absent. This difficulty becomes particularly acute when whole families are absent and no responsible person remains at home to answer the enumerator's questions. However, the de facto approach also suffers from this defect in that it involves obtaining full particulars about visitors, many of whom will be absent at the time of the interview and who may have little connexion with the household in which they stayed.

Both the de facto and de jure methods allow the enumerator a loophole: any unwanted or dubious case can be excluded on the grounds that he belongs to the category not enumerated; this is one reason why the comprehensive method is often favoured.

It will be seen that the balance of the arguments between the three methods as regards accuracy is by no means clear. Perhaps de facto wins by a small margin.

(c) Needs of the user

At the national level the two populations should agree except for foreign residents and emigrants abroad. If these categories are important they are likely to be enumerated as a special case, whatever system may be adopted for the main enumeration. Hence for users of population data at the national level there is no strong preference.

Use of the de jure population for analysis tends to eliminate the effects of very short-term migration, which is often strongly specific in terms of demographic characteristics (mothers moving to hospital to have a baby;

movements of seasonal workers, etc.). The demographer therefore prefers to work with the de jure population, unless he is working with large enough regions for the effects of migration to cancel out, or to be separately measurable.

Other users of population data at the sub-national level, such as physical planners, educational planners, etc., may prefer either basis and very often like to have both. In urban areas mobility is usually so high that the de jure population concept may be completely unrealistic. In a few countries where seasonal migration is very heavy the same may be true of rural areas.

Data on households are also normally referred to the de jure population. However, as we shall see later such data are of very limited value in Africa.

From the above it is clear that, for the user, there is no systematic advantage in either system; the largest number of users is likely to be satisfied if comprehensive enumeration is adopted.

(d) Compatibility with other definitions and operations

The de jure population clearly has a greater degree of permanence than the de facto population. This favours de jure enumeration whenever a follow-up is planned. In particular, in the demographic multi-round follow-up survey the essential principle is to identify the same households and persons after an interval. Most African populations are so mobile that this would almost rule out de facto enumeration for such surveys: the proportion of changes between rounds would be so high that the follow-up would lose its purpose. The same applies where it is planned to use the list of persons drawn up by the survey for later sampling.

Finally, the basis of enumeration for the population has to be in line with the basis of enumeration of vital events. This is the subject of the next section.

Enumeration of vital events

Unlike the enumeration of the population, methods of enumeration of vital events cannot be classified simply as either de facto or de jure. There are three possibilities. We can record:

(1) Deaths of, and births to, the enumerated de jure population, no matter where the events occur.

(2) Deaths of, and births to, the enumerated de facto population, no matter where the events occur.

(3) All births or deaths which take place in the sample area, no matter to whom they occur.

Method (3) is sometimes called "de facto" but this usage causes confusion with (2) and is not recommended.

If method (1) is used, the base population should be enumerated on a de jure basis, whereas methods (2) and (3) correspond to de facto enumeration of the population.

Within this requirement, the remaining choice depends on convenience and accuracy in data collection. This may be different for births and for deaths. It also depends crucially on the technique used for data collection: single round retrospective survey, multi-round follow-up survey, or continuous registration. We consider each case in turn.

Single round retrospective survey

(a) Deaths. In a single round survey, deaths cannot be recorded for the population enumerated since dead people are not enumerated. The only feasible basis for recording deaths in a single round survey is to ask one of the following questions:

De jure case : Did anyone die who at the time of his death was a member of this household?

De facto case : Did anyone die here (or in this household)?

The second of these is equivalent to method (3) above. It would need supplementing by statistics on deaths in hospitals. In practice retrospective mortality questions rarely give even roughly plausible results in Africa, in either of the two forms. The distinction between the two is therefore somewhat academic.

(b) Births. The best results will come from questioning women who are present or resident at the time of the interview, which favours methods (1) and (2). In a culture where women can be interviewed, method (2) should have the advantage because it more often involves recording events to women who are present to be interviewed. Whatever method is used, we have to add births during the reference period occurring to mothers who have died during the period.

Multi-round follow-up survey 1/. We have already seen that the follow-up method can only work well with de jure enumeration of the population.

(a) Deaths. The essential advantage of the follow-up method is that it enables one to name a person and ask what has become of him, instead of putting the vague (and upsetting) question: "Has anyone died?" This advantage depends on the reference population being that enumerated (preferably de jure) in the preceding round. A supplementary question is required on deaths to babies born within the period; such babies can be obtained as in (b) below.

1/ A multi-round survey in which the follow-up method is not used - i.e. in which no attempt is made to link the lists of different rounds - should be classed for the present purpose with the single round retrospective survey.

(b) Births. As in the retrospective survey, the best results will come from questioning people who are present or resident now, with a supplementary question on births to mothers whose death is recorded in (a). The use of a slightly different reference population for births and deaths causes little inconvenience. The question is discussed more fully in Chapter 11.

Continuous registration. Since the registrar is present continuously or makes very frequent visits, there is an advantage in using the method that is simplest to define, namely method (3), both for births and deaths. This involves recording all events in the sample area, no matter to whom they occur.

It will be seen that the above recommendations conflict when it comes to the dual record (PGE) method, which is a combination of multi-round survey and registration. This means that either the survey or the registration must use a less-than-optimal method; alternatively a decision may be taken to limit the matching between the two series of events to those events which occurred both within the sample area and to the enumerated population. This difficulty is examined more closely in Chapter 11.

Basis of enumeration: Summary

(a) Enumeration of the population

(1) Certain users of population data prefer to work with data obtained with the dejure basis of enumeration, others the de facto basis. For many users both are valuable. These considerations favour data collection on a comprehensive basis.

(2) Convenience and accuracy on the whole favour de facto enumeration in the case of retrospective (or single round) surveys though the case is arguable. But the advantage swings to de jure enumeration if the multi-round follow-up method is being used. In the case of the dual record method, there is a conflict, which will be examined further in Chapter 11

(3) If de facto enumeration is used, a moving reference date is recommended based on the night preceding the interview.

(4) If de jure enumeration is used, a definition of residence is required in terms of (i) household membership (see next section) and (ii) length of stay. Recommended for the latter: the place or residence is the place in which the person has lived most during the last 12 months.

(5) A separate basis of enumeration can be used for persons abroad if this seems appropriate.

(b) Enumeration of events

(6) In general, the basis of enumeration should be compatible for events and for the population. This rule requires modification in the case of enumeration of deaths in a single round survey.

(7) For a follow-up survey, it is recommended to record: (a) deaths occurring to persons enumerated (preferably de jure) at the start of the reference period plus deaths to babies whose birth is reported in (b) below; (b) births to mothers enumerated at the end of the reference period and to mothers whose death is recorded in (a).

4.2 DEFINITION OF HOUSEHOLD

A definition of "household" is needed (a) because the household is the unit of enumeration and the enumerator must therefore be told whom to include in the same questionnaire; and (b) because statistics on households may be required from the survey. In some cases the definition is needed for a third reason, namely (c) because the households enumerated in the demographic survey are to be used as sampling units in a subsequent survey.

In practice in Africa it is not possible to produce a strict definition of the household in such a way that every enumerator will make the same grouping of persons into households. For this reason, statistics of households in Africa are often of little value. The definition of the household serves mainly the first of the purposes quoted above, namely as an aid to the enumerator in deciding which persons should go together in the same questionnaire.

The United Nations recommended 1970 census definition of "household" reads as follows:

> The concept of "household" is based on the arrangements made by persons, individually or in groups, for providing themselves with food or other essentials for living. A household may be either: (a) a one-person household, that is, a person who makes provision for his own food or other essentials for living without combining with any other person to form part of a multi-person household or (b) a multi-person household, that is, a group of two or more persons who make common provision for food or other essentials for living. The persons in the group may pool their incomes and have a common budget to a greater or lesser extent; they may be related or unrelated persons or a combination of both.

The above definition may be included in the appendix of the enumerator's manual, but a more practical form for everyday use by the enumerator is the following:

> A household is a group of people who live and eat together.

More important than defining the term is to list the specific borderline cases which cause uncertainty. We give below the main special cases with the recommended treatment for each.

Special case	Treatment
Lodger	Separate household (1-person household)
Boarder	Include with the household if at least 1 meal per day is normally taken with the household
Servant	Separate household

Adopted child	Include in the household
Group of unmarried men sharing lodging	One household if they make common arrangements for eating. If not, count as several 1-person households
Several wives of one husband, with their children	One household if they live in the same compound. If not, count as several households each with its children.

In many African countries there are regions in which rural people live characteristically in large groups - perhaps 30 or 40 persons in one compound. A decision should be taken in advance about such categories and any other difficult cases which are known to be frequent, and explicit instructions should be given to the enumerators about each specific type of case.

Head of household. In most questionnaires the first line is reserved for the head of household. Any attempt to define by general rules who this should be is likely to cause lengthy and fruitless discussion and ultimately to confuse the enumerator. The best procedure is simply to accept as head the person who is stated to be head by members of the household; there will rarely or never be any disagreement.

CHAPTER 5

TOPICS FOR INVESTIGATION AND CONTENT OF THE QUESTIONNAIRE

5.1 MAIN DEMOGRAPHIC TOPICS: THE COMPONENTS OF POPULATION CHANGE

This section covers the topics of sex, age, fertility, mortality and migration. For each topic we shall consider exactly what information is needed and how to obtain it.

A. Sex

The only difficulty arises over the sex of infants. In many African surveys and censuses more girls than boys have been reported under the age of 6. 1/ Enumerators should be instructed not to take the sex of an infant for granted, nor to deduce it from the name, but always to ask specifically whether the child is a boy or girl in every case.

B. Age

In contrast to sex, age is probably the most difficult topic on which to obtain accurate data in Africa, simply because so many people do not know their age or date of birth. Yet it is a topic of fundamental importance both for demographic analysis and for many other aspects of development planning. The following discussion is divided into two sections: the first covers the form in which the question should be asked and recorded, the second considers the methods which enumerators can use in order to estimate age as accurately as possible.

Form of the age question

(a) Broad groups or single years

In African censuses in the 1950's and earlier, age information was generally obtained in broad age-groups. However, this procedure means that some available information on age is deliberately not used. If, instead, narrow age-groups are used there will be so many groups that the method is no simpler than using individual years of age. The method of age-groups has therefore been abandoned almost everywhere in favour of single years of age. The latter is recognized to be more convenient both for recording in the survey and for the user. Moreover in every African country there is a substantial and growing number of people who know their age accurately; within some categories of the population such people may be in an overwhelming majority - for example in the school population. There is no advantage in throwing away this information just because it is not available for everyone. The use of single years if therefore recommended.

1/ There is a popular myth in Africa that far more girls are born than boys. Of course there is no valid basis for this whatever.

(b) Definition of age

Age should be given in terms of completed years or, which is the same thing, age "at the last birthday".

For children under the age of 12 months the "age in years" would of course be 0. However, enumerators (or perhaps mothers) are reluctant to give a child's age as zero. It is usual therefore to instruct the enumerator to obtain the age in months for children under 1. This also helps by giving a check of age against information on recent births, besides throwing some light on patterns of age misreporting. There is a good case for extending this procedure to children up to 2 years and this has been done in several surveys.

(c) Age or date of birth

In Europe and America, a question on date of birth has been shown to give better results than the question asking age as such. It does not necessarily follow, however, that this will be so in Africa. When a person does not know his date of birth, to put the question in this form may only mean asking the enumerator to do two things instead of one: he first estimate the person's age, and then calculates the date of birth by subtracting the age from the date of the survey. An additional source of error is thereby introduced in the form of the subtraction sum.

Furthermore, when most people have no birth certificate and do not celebrate their birthday, it is often useless to ask for the day and the month of birth; we can only ask for the year. But if the survey is held near the middle of the calendar year, the conversion of the information on year of birth into age causes a nuisance when processing and analysing the data and can introduce an additional bias: for example, if the survey is held in July 1970 and a person's year of birth is given as 1954, he may be either 15 or 16 at the time of the survey.

The following arguments may be made in favour of a question on year of birth. (1) It is a fixed date which a person may know well, whereas his idea of his age, which changes from year to year, may become confused. (2) Asking for the year of birth may encourage the enumerators to make use of their event calendar or similar aides (see below). (3) An appreciable proportion of the population may in fact possess a birth or baptismal certificate, or have their date of birth inscribed in a family bible; to ask for date of birth may cause these documents to be unearthed, whereas the age would otherwise be estimated in a slipshod and inaccurate manner. The strength of these arguments will clearly vary from country to country, and it is not possible to make any firm recommendation on this point.

Some countries have adopted a compromise, and have allowed the enumerato to ask either for date of birth or for age: the date of birth is to be completed when it is known exactly, otherwise the estimated age is to be given. This procedure was adopted, for example, in the 1966 census of Algeria and in the 1969 census of Zambia. Again, its usefulness will depend on the proportion of the population who do in fact know their date of birth, and on

the extent to which the enumerators follow the instructions. Thus in Algeria, where most births are now being registered, the use of both questions almost certainly improved the quality of the overall age data, as well as producing results of interest in their own right. In Zambia, however, it became clear from the results that the enumerators did not follow the instruction to record the date of birth only for those who knew it precisely: the age distribution shows heaping on ages ending, not only in 0 as is usual, but also in 9. As the census took place in 1969, this suggest that the years of birth had likewise been rounded to dates ending in 0.

Another circumstance where year of birth may be more convenient than age is the multi-round survey. A person's age would normally be determined in the first round of the survey but will change as the survey proceeds from round to round; meanwhile newcomers into the survey will have their age recorded at the time when they are first picked up by the survey. These variations can cause complications in the processing and analysis of the data, particularly as regards the computation of age-specific rates. If, however, a question on date of birth is used, uniformity will be preserved throughout. This potential advantage, however, will depend largely on the type of questionnaire being used and on the duration of the survey.

Methods of estimating age

(a) Event calendars

The use of calendars of well-known events to assist enumerators in pinpointing the dates of birth of their respondents is the best known and most widely used method of estimating age. In practice, however, various drawbacks have been found with this method.

- It has frequently been found that the population being enumerated is unfamiliar with many of the events listed in the calendars. This is particularly true of political events which may have seemed of great importance to the educated persons drawing up the calendars but which in fact had had relatively little impact on the lives of the majority of people, particularly those living in remote rural areas.

- Questions as to whether a person remembers, or associates his birth with, a particular event are liable to be put in a leading manner. The respondent may readily acquiesce to these suggestions out of politeness, or in order to conceal his ignorance, or to put an end to the tiresome string of questions to which he does not know the answer.

- The effective use of the calendars is a complex operation which cannot be applied blindly. The method must be varied according to the nature of the respondent - e.g. children for whom the answers are being given by the parents; adults who are present and are answering for themselves; adults who are absent or who cannot or will not answer for themselves.

- It is also a laborious and time-consuming operation. Enumerators are often under pressure to complete as many interviews as possible, and cannot spare the time to continue probing until a really accurate estimate of age has been reached.

Thus both the events included in the calendars and the instructions given to the enumerators on how to use them have often been at fault. In many surveys the method has been explained in broad terms to the enumerators but they have not received any detailed instructions or coaching. This means that they have to work out the procedure for themselves. Although the broad principle of the method is simple enough, the detailed procedure is complex.

For example, for adults seen by the enumerator and answering for themselves, the following steps are involved:

(1) Since one cannot read out all the events in the calendar, a preliminary estimate must be made of the respondent's age in order to decide the point at which the enumerator should start reading out the events from the list. Let us say that this point is fixed at 5 years before the estimated date of birth. This leads to the following steps:

*(2) Add 5 years to the respondent's estimated age and subtract the result from the date of the survey.

(3) Find the corresponding event in the calendar. Read it out and ask: "Do you remember this?"

(4) If the answer is "no", read the next event listed. Continue thus until an event is remembered.

(5) For the remembered event ask: "What were you doing at that time?"

(6) From the answer, estimate the respondent's age at the time of the event.

*(7) Calculate the respondent's present age by subtracting the date of the event from the date of the survey and adding the result of step (6).

This procedure must be used intelligently. It must be understood at least by the enumerator and preferably also by the respondent. For example, if the respondent does not understand the purpose of the questions, he may reply to the question - "What were you doing at that time?" (step 5 above), by saying - "I was living at such-and-such a place."

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* These steps can be simplified if the calendar shows for each event, the number of years before the date of the survey.

This reply is useless; the enumerator must recognize this and probe for a further reply on which an estimate of age can be based. Thus the enumerator, in addition to following the above complex procedure, must be ready to use his own initiative when the procedure goes wrong. Note, moreover, that the procedure described above covers only one case. Where, for example, parents are being questioned about the date of birth of their child a different procedure will be used.

Even when there is no misunderstanding of the method it is clear that errors can occur. One notable event may be confused with another: for example, one epidemic with another, one famine or drought with another; or the respondent may simply be mistaken in his memory of the relationship between the public event and his private situation at the time. Thus the event calendar can in no sense be regarded as infallible even in the best hands. If used correctly and intelligently it can help; if used wrongly it can be worse than useless.

Above all, if it is decided to use the method then arrangements must be made to spend a great deal of time at the enumerators' training session in coaching and practice on this one problem. Five days would seem a minimum for training an enumerator to use the method effectively.

(b) Tribal age grades

Some African tribes have systems of "age grades" or "age sets" - groups of indiv duals who have undergone circumcision or some other form of rite de passage at the same time or within a specified period, and these age grades often plav an important role in the hierarchy of tribal society. If the relationship between the age grades and age in years can be established, useful indications of age can be obtained.

This method has the great advantage that most people, when asked what age grade they belong to, can answer immediately and clearly so that no probing is required. It is however of limited applicability. Many tribes and peoples have no age grade systems, and among others the age grades may be so broad as to be virtually useless for this purpose. Elsewhere there may be important local variations in the system and nomenclature of the age grades even within the same tribe, and considerable care and research for small geographical areas is necessary before the conversion tables showing the relationship between the age grades and age in years can be drawn up.

(c) Relative ages of persons in the same household or locality

In most African communities the people, although ignorant of their age in years, may nevertheless be conscious of whether they are older or younger than other members of their household or village. This awareness arises from the relationship between age and status in tribal society. This fact may be exploited: once the ages of one or two persons have been established with a fair degree of accuracy, the ages of their relatives and neighbours can be estimated in relation to them.

It is, however, a technique which, like the event calendars, requires time and probing if it is to be utilized effectively. Prolonged coaching is essential. Popular as it is, the method should still be regarded as experimental, and seems to work well only in somewhat specialized circumstances.

C. Fertility

Questions on fertility asked in most demographic surveys in Africa may conveniently be divided into two categories: those concerned with current fertility - i.e. births occurring during a specified period prior to the survey; and those concerned with lifetime fertility - i.e. the total number of children ever borne by the women enumerated in the survey. The two types of question are essentially complementary. By checking and comparing one set of data against the other, much can be done to adjust for reporting errors. 1/ This is particularly true if the data on current births are tabulated by birth order - i.e. the total number of children borne by the mothers. We therefore recommend that questions on both current and lifetime fertility should be included in any demographic survey conducted in Africa. 2/

In putting questions to women on fertility the enumerator needs an instruction regarding the age limits of the women to be questioned. Should he ask all women above 10, above 12, above 14 - or simply all women who have ever been married? If the age limit is placed too low the enumerator may cause embarrassment; if too high, he may miss some births. At the other end of the scale, should he exclude women who are too old?

This problem is not in fact worth a great deal of discussion or research since no matter what instructions are given it is probable that most enumerators will not ask the question when it appears likely to cause embarrassment. We recommend just one rule, which should take the form:

Ask all women aged X or over,

where X is any age not greater than 15 which may be chosen by the survey planner. The age X should then be specified in the enumerator's instructions. The use of an upper age limit is not recommended; in most surveys lifetime fertility is required even for old women, and in any case where this is not so the age of older people is so difficult to estimate accurately that it seems unwise to fix any age limit.

Current fertility

Three types of questions can be considered:

1/ See United Nations, "Methods of Estimating Basic Demographic Measures from Incomplete Data".

2/ If the "pregnancy history" method of obtaining data on lifetime fertility is adopted (see end of this section), data on current fertility can also be extracted from it, as the date of each birth is obtained.

Retrospective question on births in the preceding 12 months

Question on date of last live birth

Follow-up question: births since the preceding round of the survey.

These will be examined in turn.

(a) Retrospective question on births in the preceding 12 months

A question on births occurring during a specified period - generally 12 months, but in some cases some other similar interval - before the survey has been included in most African demographic surveys. Such questions have normally been asked of the women enumerated in the survey, but in some surveys (particularly those in French-speaking countries) they have also been asked of the head of the household - i.e. whether a birth has occurred "in the household" or "in the family" during the period in question.

Critical analysis of the data obtained in answer to these questions has indicated that in some cases (e.g. Upper Volta 1960-61, Chad 1963-64) the results have been accurate to within some 5 or 6 per cent. But more frequently they have been shown to be subject to substantial errors. The causes of these errors are generally thought to fall into three main categories:

(1) Dating errors. Births which in fact took place during the reference period are excluded, as they were thought to have occurred before the beginning of the reference period; or, conversely, births which took place before the beginning of the period are erroneously included.

(2) Recall lapse or other failure leading to omission. The respondent fails to report births, particularly those of children who died shortly after birth.

(3) Errors due to the low incidence of the events. Women who have had a child during the preceding 12 months constitute only some 4-5 per cent of the population enumerated; survey research has shown that when a question is asked whose answer nearly always goes the same way, then certain enumerators tend to miss the rare response which goes the other way (probably because they begin to take the answer for granted instead of asking). In this way births are missed.

In some cases, the net effect of these errors has been to reduce or inflate the total number of births reported for the reference period, but the bias appears to be independent of the age of the mother. In these circumstances, correction procedures can be used which are described in the United Nations manual "Methods of Estimating Basic Demographic Measures from Incomplete Data". In other cases, however, the errors can be shown to have biased not only the total number of births, but also the shape of the age-specific fertility distribution; when this happens the correction procedures lose most of their validity (see also Chapter 12).

(b) Question on date of last live birth

In some recent censuses and surveys in Africa, questions on births in the last 12 months have not been asked; instead, women have been questioned as to the date of their most recent live birth. The question asks first only for the year when the last birth took place, but if the women gives a date for the last birth within the three calendar years prior to the survey, the month is then asked for. Women bearing children during the 12 months preceding the survey are then distinguished separately in the processing. This approach has been shown to possess certain advantages:

(1) The question must be answered for all women who, in answer to the question on life-time fertility, claim to have given birth to a live-born child. Errors due to the low incidence of the events are thus eliminated. It also places the analyst in a much stronger position for making corrections and adjustments to the data, as will be described further below.

(2) The information on women whose last child was born more than 12 months prior to the survey is also of value: the distribution of women bearing children between 12 and 24 months before provides supplementary data on the shape of the age-specific fertility curve; further, information on the patterns of error is provided in the case of women who state a date of last birth such as would make their own age at the time of the birth either impossibly young or impossibly old.

There are also certain disadvantages in this approach which should be considered.

(1) The question is a difficult one, as are all questions involving dating of events in African surveys. The older women, who may have borne their last child several years before the survey, will have particular difficulty in answering the questions correctly; and for all age groups there are likely to be some women - generally between 5 and 10 per cent - who will be "not stated" as to date of last birth. These errors are, however, of secondary importance; we are less concerned with the births which took place several years before the survey than we are with those occurring during the preceding 12 or 24 months; and if the fertile women who are "not stated" as to date of last birth are tabulated by age group and parity, suitable pro rata allocations can be made.

(2) The question is not "conceptually complete": we do not obtain information on women bearing more than one child during the 12 months preceding the survey, nor on births during this period to women who have themselves died. However, the combined effect of such omissions is unlikely to amount to more than 5 per cent, and probably not more than 3 per cent, of current births. Suitable adjustments can be made if necessary. Alternatively, such births could be covered if, in addition to asking each fertile women for the date of her last birth, a question on births in the last 12 months is asked on a household basis.

(3) Even when these adjustments are made, analysis shows that current births are still under-reported. Field observations suggest that one reason may be the following: enumerators find the question difficult and tedious and as a result, instead of asking for the last birth, they assume that the youngest child living in the household represents the last birth. They then enter his date of birth as the answer to the question. This error could perhaps be combatted by including an additional question as to whether the last-born child is still alive. Even if this has no effect on the enumerator it would at least show up the error, since the mortality rate among these "last births" would be too low. This provides the analyst with firmer grounds for correcting the figures.

All in all, the question on date of last live birth seems preferable to that on births in the last 12 months. Is is therefore recommended and should be used whether in a single round survey or in the first round of a multi-round survey.

(c) Follow-up question: births since the preceding round of the survey

This method is described in fuller detail in Chapter 11. But it may be said here that there are obvious reasons for expecting that it should give improved results on current fertility, since errors of dating are practically eliminated, and if a question on current pregnancy is included, probing in the follow-up rounds should be more effective. Relatively few multi-round follow-up surveys have been carried out in Africa and at the time of writing there is not enough evidence to show whether the method has in practice eliminated under-enumeration of births. The same remarks apply equally to the dual record method, which is also discussed in Chapter 11.

Life-time fertility

Two types of approach have been used to collect information on life-time fertility in African surveys:

Question on the number of children ever born

Pregnancy history questionnaire.

These will be examined in turn.

(a) Question on the number of children ever born

Most demographic surveys conducted in Africa have included a question for all adult women (or in some cases for all ever-married women) as to the number of children they have ever borne. Such questions have normally referred to live births only, though in a few cases still-births have also been included. However, in African surveys it has been found difficult to distinguish still-births from miscarriages; any definitions based on the duration of the pregnancy are unworkable. We recommend asking for live births only, defined as children who cried after birth.

Questions on the number of live births have frequently also required a breakdown into the number of children who are still alive and the number who have died. Such a breakdown enables the data to be used for the estimation not only of fertility but also of infant and child mortality. This will be further discussed later in this chapter under the heading of mortality.

The data obtained from these questions are subject to errors of both faulty omission and faulty inclusion. These errors may be summarized as follows:

Faulty omissions:
- children who died in infancy
- children who have left the home
- children born to another husband

Faulty inclusions:
- still-births
- children born to the current husband by another wife
- adopted children
- grandchildren

Every effort should be made to forestall these errors both in the design of the questionnaire and in the training of the field staff, although even with the best efforts it is unlikely that the errors can be eliminated altogether. As a first step in this direction, it is recommended that the question on the total number of live births should be broken down into three parts:

- the number of children now living at home
- the number of children now living elsewhere
- the number of children who have died.

The first group can then be checked against the household members listed in the questionnaire.

The big advantage of the question on the number of children ever born is that there is no error of dating, since there is no reference period. Furthermore, since a much larger number of person-years are involved than with questions on current fertility, the sampling errors are much lower. (The question of sampling error is discussed further in Chapter 8).

(b) Pregnancy or maternity histories

In view of the potential errors and biases in data obtained in answer to questions on the number of children ever born, the more detailed approach of the pregnancy history has sometimes been advocated. It is hoped that by greater probing more accurate results will be obtained. The reasoning behind this approach is as follows:

First, in many African societies, the process of counting one's offspring or possessions is both unfamiliar and distasteful, and is thought to bring disease, death or bad luck. Yet, although reluctant to state their number, a man or woman may nevertheless have a clear mental pictur

of each one. In the case of cattle, for example, a man may not know how many he possesses, but he can, without counting them, tell at once if any are missing. Thus by asking a woman to describe separately each one of her pregnancies and its outcome, one can build up a more accurate picture of her life-time fertility. In contrast, by simply asking for the total numbers one encourages hasty and ill-considered answers.

Secondly, by dating each pregnancy and arrangimg them in chronological sequence, the enumerator can see whether there were any unusually long periods during which the woman apparently did not conceive. By further probing he may then bring to light pregnancies and births which would otherwise have been omitted.

Thirdly, the detailed information supplied on the date of each birth in the pregnancy or maternity history opens up various possibilities for the examination of recent trends in fertility. In this respect it should be observed that if a country wishes to trace movements in fertility, it is unlikely to be able to achieve this by continuous observation of a sample. Unless an enormous sample is used, the small year-to-year changes in the birth rate will be masked by sampling errors - to say nothing of the non-sampling errors - which will almost certainly tend either to improve or to deteriorate with time, thereby introducing spurious trends into the figures. In these circumstances the use of maternity histories offers more hope of success. It should be observed, however, first, that at the time of writing no such analysis of maternity histories in order to determine fertility trends has been made with African data; problems arising from the distortions due to dating errors may be serious if not intractable. Secondly, relatively large samples would be needed; the sample sizes of most of the KAP surveys, which have included pregnancy histories for some 4,000 women or less, would be inadequate for this purpose.

Fourthly, we have seen that questions on the date of the last birth suffer from the defects that they do not necessarily cover all the births occurring within the 12 months preceding the survey, and that enumerators sometimes record the date of the wrong birth (points (2) and (3) on pages 45 and 46). With a pregnancy or maternity history, where they would be required to record the date of every birth, these defects could be overcome.

When this method is used, the principal items of information which are normally obtained in respect of each pregnancy are:

Live births:
- name (if any) of child
- sex of child
- date of birth
- if still living, present place of residence
- if dead, date of death

Miscarriages and still-births:
- date of prenancy
- duration of pregnancy.

In tropical Africa, enquiries of this kind have generally been conducted on a fairly small scale; in the few cases where they have been incorporated in sample surveys conducted on a national scale, the results have not yet been published. Thus the extent to which they in fact succeed in producing more accurate results cannot yet be assessed.

Although improved results can reasonably be expected, for the reasons outlined above, there are certain difficulties and drawbacks inherent in the method which must be considered:

(1) The method is complex and time-consuming; it therefore requires a higher calibre of field staff than is normally readily available in Africa; the interviews will be long and the enumerators will be able to complete fewer in a day; the cost of the field work will therefore be increased. The data obtained are also difficult to edit and process.

(2) The dating of the events, which is the key to the whole approach is, in Africa, difficult, inaccurate and frustrating for both enumerator and respondent. It will involve extensive use of event calendars, the complexities of which have been discussed above. We have already seen that a question on the date of the <u>last</u> live birth can cause difficulties; these difficulties will therefore be repeated in respect of all the other pregnancies. Faced with a barrage of questions to which she does not know the answer, the respondent is liable to become exasperated. At the same time the enumerator may be discouraged and resort to slipshod methods of dating.

(3) Experience shows that in some cases probing into the details of dead children and pregnancy losses, instead of increasing the accuracy of the responses, can cause resentment and jeopardise the success of the whole interview.

(4) The method involves the use of a separate questionnaire for each woman, whereas questions simply on the number of children born can be incorporated in a general household questionnaire. The number of documents to be handled by the enumerator will thereby be much increased. The design of the pregnancy history questionnaire and the method of its completion (a series of questions must be asked in strict sequence) are described further in Chapter 6.

Finally, it should be noted that the main argument for the pregnancy history method, namely that it avoids asking the mother to count her children, is less strong that it appears at first sight. The children are to be reported in 3 categories - 6 if each is broken down by sex. In any one category the number will not be large and this is especially true of the younger women on whom the analysis mainly depends. Moreover, much the largest category is likely to be that of "children now living at home"; these are named individually in the questionnaire so that we are not relying simply on reporting of numbers. Outside this category it will be rare to find a number greater than 1.

More evidence is needed before the pregnancy history method can be evaluated. At present the arguments do not appear to justify a firm recommendation, unless there is a specific intention to obtain information on birth intervals and fertility trends.

D. Mortality

As with fertility, investigations into mortality may be divided into two categories: those which seek information on "current" deaths occurring during a specified recent period, and those which involve no dating or reference period.

Current mortality

Three types of question will be considered:

Retrospective question on deaths in the preceding 12 months

Question on date of last death in the household

Follow-up method: deaths since the preceding round of the survey.

These will be examined in turn.

(a) Retrospective questions on deaths among members of the household in the preceding 12 or 24 months

Questions of this kind have been included in many African surveys and censuses but in most cases they have not given even roughly plausible results. Besides the sources of error mentioned above for births (dating error, error of omission, error due to low incidence of the event), there is the problem that where the deceased lived alone there will be no one to question about his death. Similarly, if his death caused a break-up in the household there may be no one who can report his death as occurring "in this household". In either case the death goes unreported.

Besides the usual dating errors, another error has been observed in more than one country. In some cases the question has been asked in terms of the number of deaths; some respondents have then ignored altogether the date limit of 12 months and answered the question by copying from the lifetime fertility question the total number of children reported as born and died. Of course this is completely wrong.

Despite unfavourable experience in many African censuses and surveys, the question has occasionally given useable results with well trained and supervised enumerators. Furthermore a new analytical technique, outlined in Chapter 12, has been developed which will, in some circumstances, enable mortality estimates to be derived from the data, provided that the proportionate distribution of deaths by age is approximately valid even though the absolute number may be under-reported. The inclusion of such a question is therefore recommended. However in order to forestall errors of the type described above we suggest that the question should ask for particulars of members of household dying in the last 24 months, and that these particulars should include the name, relationship, sex, age at death, and date of death. Tabulation of

the data by sex, age and month of occurrence will then enable the patterns of dating errors to be studied, as well as revealing possible misunderstanding of the question of the type described above. Such a question may even be included in the opening round of a multi-round or dual system survey partly as a safeguard should later rounds be cancelled and partly because it serves as a check on dating errors for deaths reported at the second round.

(b) Question on date of last death in the household

This is the mortality equivalent of the question on a woman's most recent live birth. It has rarely been tried in African surveys and, when tried, does not seem to have given satisfactory results.

There are additional difficulties with this approach in the case of mortality which do not arise in the case of fertility. Firstly the problem arising from the break-up of households and the formation of new ones becomes even more serious than with the question on deaths in the last 12 months, since the question generally refers to a longer period, with greater risk of the household breaking up. Secondly, while in the case of fertility there is a cross-check with the question on lifetime fertility, there is no equivalent to this in the case of mortality.

In the light of experience the method is not recommended.

(c) Follow-up method: deaths since the preceding round of the survey

This method is described more fully in Chapter 11, but we may note here that it is in the field of mortality that the advantage of the multi-round follow-up survey is likely to be greatest. Thus, instead of the vague question - "Has anyone (we don't quite know who it might have been) died in this household in the last 12 months?", the enumerator can enquire about the survival of named individuals: "Is so-and-so, who was here last time I came, still alive?".

The follow-up method must be supplemented by a question on the survival of babies born since the preceding round of the survey. In the interview, this will appear as a supplement to the question on births since the last round.

As mentioned above, not enough multi-round surveys have been done in Africa to enable their success to be judged accurately. However, the two-round follow-up surveys of rural Nigeria (1965-66) gave one of the most plausible looking life tables yet obtained for any country South of the Sahara - though unfortunately there is no other source of information on mortality in Nigeria against which these results can be checked.

The dual record (PGE) method can be expected, in principle, to be at least as effective as the follow-up survey as a source of information on current mortality. The choice between single-round surveys, multi-round surveys, and dual record systems is discussed in Chapter 12.

Mortality questions with no specific reference period

Two possible questions of this type will be considered in this section:

Question on survival of children;

Question on survival of parents.

(a) Question on survival of children

We recommended above that, when women are asked for the number of children ever born, the answer should be broken down into the number of children (i) living at home, (ii) living elsewhere, and (iii) now dead. The proportions of the latter group tabulated by age of mother can be used to provide estimates of mortality during the first 5 years of life (see Chapter 12). They are based primarily on the results from women in the age-groups 20-24, 25-29 and 30-34. (Information from women older than this tends to be too unreliable besides taking us too far into the past, when mortality may have been different).

If the number of children surviving and dying is recorded separately for the two sexes, mortality rates by sex can be obtained. If not, arbitrary separation factors will have to be used.

These estimates of infant and child mortality are generally thought to be appreciably more reliable than those based on deaths in the last 12 months, for the following reasons:

- The questions involve no reference period and hence are not subject to dating errors.

- The data are based on a larger number of person-years and are therefore subject to smaller sampling errors. In fact they comprise births occurring up to 20 years prior to the survey, and it may be argued that if mortality has been declining rapidly, the estimates will be biased. In fact, however, they are heavily weighted by the more recent births, so that unless the reduction in mortality has been unusually large, the bias will be slight.

- The analytical techniques are "robust": i.e. the estimates are insensitive to age mis-reporting or to differences in the patterns of fertility and mortality from those of the models used for the construction of the estimation procedures.

It must be emphasized, however, that the data provide estimates of infant and child mortality only, and cannot be used for the estimation of adult mortality.

(b) Question on survival of parents

In order to fill this gap of adult mortality, it has been suggested that the questions should, as it were, be reversed: instead of asking parents about the survival of their children, one should ask the children about the survival of their parents. Thus questions as to whether each person's father and mothe

are still alive have been included in several African censuses and surveys. At the time of the preparation of this manual these include the surveys of Chad (1964), West Cameroon (1964), Mauritania (1965), Lesotho (1967-68 and 1971-72), Malawi (1971), Tanzania (1973) and Sierra Leone (1973), and the censuses of Kenya (1969), Uganda (1969), Botswana (1971) and Gambia (1973). Procedures for converting the results into standard life table functions have been drawn up and are discussed further in Chapter 12. They have yielded plausible results, consistent both with the estimates of infant and child mortality derived from proportions of surviving children, and with estimates of adult mortality derived from other sources (e.g. inter-censal survival).

However, as is discussed in Chapter 12, the techniques of analysis are based on certain assumptions; the nature and magnitude of the biases likely to arise if these assumptions do not hold good are currently under investigation. One such bias, however, concerns the response itself and should be noted here. In Africa, the words "father" and "mother" are often used loosely not only to denote a person's biological parents, but also to include foster parents or simply as terms of respect for members of an older generation. The substitution of foster parents for true parents in the response might clearly lead to bias since the process of adoption may take place because of the mortality one is trying to measure. Such errors can best be forestalled by wording the question in such a way as to make it clear that it refers to the true, biological parent. Suitable terms exist in most African languages, so that translation may be worked out during the preparations of the survey and included in the enumerators' manual; these wordings should then be hammered home during the training of the field staff.

On the other hand the approach has several considerable advantages: the questions are simple and require no probing; they involve no dating or reference period; they take up little space on the questionnaire; the results are simple to code, punch and tabulate; and they involve a large number of person-years and hence the sampling errors are small.

Thus, despite the uncertainties arising from the various sources of bias, questions on survival of parents are among the most promising methods of obtaining data on adult mortality in single-round surveys. We therefore recommend their inclusion, not only in single-round surveys and censuses, but also in the opening round of multi-round surveys. Only by obtaining data from different independent sources can the validity of the estimates be assessed.

The question should be asked in respect of all persons in the sample.

E. Migration

Migration presents a special problem in almost every one of the various aspects of survey design. There is a special problem as regards whom to question about migratory movements; a special sampling problem; a coding problem; a problem of time reference; a problem of tabulation and presentation, and a problem of projection which itself raises a broader problem of the usefulness of migration data. We consider these problems first before entering into details of methods of questioning.

(i) Whom to question

While internal migration, and immigration into the country from outside, can be investigated by questioning people as to where they have come from, there are obvious practical difficulties in obtaining data on people migrating out of the country, since the emigrants are not present to answer questions. A few African countries have frontier controls from which some information on external emigration can be obtained and in some countries nearly all the emigrants pass through some kind of employment agency. But where this is not so, the only source of data on external emigration would appear to be a multi-round follow-up survey or a dual record system. Even these methods are obviously far from reliable: they still depend on secondhand information about the emigrant.

(ii) Sampling problem

Migration data are subject to large sampling errors if cluster sampling is used. The intra-class correlation associated with cluster sampling (see Chapter 7) is perhaps about five times as high as in the case of fertility and mortality. Unless this fact is taken into account in designing the sample and fixing the objectives, the sample may be found to be inadequate to permit any worth-while conclusion.

(iii) Coding problem

Rural people can generally say what village they come from, but often do not know the region or province, commune, district or other administrative division. Obviously the tabulation is not needed in terms of villages but in terms of some larger geographical unit, say "regions". 1/ This presents a coding problem. How do we translate the data from villages into regions? This cannot be done entirely in the office because in all countries there are many villages which have the same name; in every ambiguous case we would like to get back to the informant for fuller details. In practice this work is perhaps best done by the enumerator and informant together at the interview itself: the enumerator is required to record only the region but where he cannot get this information from the respondent directly, he asks for the locality and tries to locate it more exactly by supplementary questions, with the help of a map if necessary. Obviously this is complex and time-consuming and still not completely reliable. There seems to be no simple solution to this problem. In most surveys it has been ignored, and indeed if we are prepared to accept a fairly wide margin of error this may well be the most practical policy at the stage of data collection. However the existence of this source of uncertainty should at least be mentioned in publishing the results. The problem is more serious in some countries than others.

1/ Geographical and administrative units are differently named in different countries. We use the term "region" here for convenience, to denote some geographical unit which is large, but smaller than a whole country. In many countries the word would be "province".

(iv) Problem of time reference

The problems discussed under "de jure" enumeration concerning the definition of residence arise all over again when we try to classify migratory movements. For example, if we ask "Where were you before you came here?" we have to consider how long the respondent must have stayed in a place in order to qualify as having "come from" it. This increases the complexity of the interview and of the instructions given to enumerators.

(v) Problem of tabulation and presentation

A migratory movement has three aspects: (i) the point of departure, (ii) the point of arrival, and (iii) the date. Each of these elements must be grouped in some way in presenting the results. Further, a given individual may move any number of times in a given period. The possibilities for analysis are almost endless. For example, one might tabulate province of birth by province of present residence (the date variable then disappears because the reference period is the lifetime). Or one might classify present residence as urban or rural and tabulate by date of arrival. Some possible tabulations might require a larger or less clustered sample than is available. Others might need more precise responses than can be obtained (for example, we can scarcely ask the informant to classify a place as urban or rural). In the field of migration more than any other it is indispensable, for efficient planning of the survey, to draw up in advance a precise tabulation plan in the form of skeleton tables; a very rough estimate should then be made of the numbers to be expected in the cells and the implications should be carefully studied in terms of sampling error, question design, coding, and the usefulness of the final result.

(vi) Problem of projection

As was pointed out in Chapter 3, migration is directly influenced by government action and by a variety of factors which can easily change quite suddenly from one year to the next. The position is quite different with fertility and mortality. For this reason there is no sound basis for projecting migration data into the future. In a sense, therefore, all information on migration is historical and nothing more: it tells us what has happened but it gives almost no clue as to what will happen. It is important to face this fact when planning a survey and to consider very critically whether there is really any need for such historical information.

(vii) Note on migration data collected in urban areas

The most serious difficulties in collecting information on migration are encountered in urban areas. Most African towns are not only growing rapidly, but they are also experiencing a very rapid turn-over of population: there is a constant movement to and fro between the town and the country, and people move frequently from one part of the town to another. To find a clear pattern in these movements is not easy. Moreover, if the multi-round follow-up method is used, people enumerated in one round may have disappeared by the

next and there may be no one who can say when they went or where. 1/ In addition to these difficulties, the sampling problem is particularly troublesome in urban areas in relation to migration. New arrivals tend to settle in a few well defined areas and there is little possibility of selecting these areas in just the right proportions in the sample. (Another way of saying this is that the intra-cluster correlation for migration is particularly high in urban areas).

Yet despite these problems and limitations, migration is all too often a subject which cannot be ignored. In many countries it constitutes an important element in the rate of population growth, and demographers are frequently required to make projections, not only of the total population of a country, but also for geographical subdivisions and for the main towns and cities. They are therefore obliged to try to obtain some information on migration, however rough, through their census or survey. We now consider, therefore, the various forms of question which may be used for this purpose.

As with fertility and mortality, we distinguish data on "current" migration, relating to a fixed reference period in the recent past, and open-period questions which involve no dating or reference period.

"Current" migration

Three types of question will be considered:

Duration of residence

Place of residence at a fixed prior date

Follow-up method: movements since preceding survey round.

(a) Duration of residence

Several censuses and surveys have included a question on how long each person has been living in the place where he is enumerated. The number of persons stating a duration of less than one year gives an approximation towards the annual migration rate. Apart from the difficulties associated with all questions involving dating in Africa, the main problem arises in the case of persons who have been moving repeatedly to and from the place where they are enumerated: should the period of residence date from the time when they first came there, or from the time when they last came back? Instructions have sometimes stated that "short periods of absence should be excluded", but what constitutes a "short period"? A precise definition is needed. The same problems arise if the question is adapted for absentees and refers to the duration of absence.

1/ The multi-round follow-up method can nevertheless give a wealth of information about urban mobility, as was found in surveys carried out in Abidjan (1963), and Yaoundé (1964-65). But the problems of analysis are formidable and this type of enquiry should be regarded as a highly technical special study: it cannot be handled as a marginal addition to a general demographic survey.

If de jure enumeration is being used (see Section 4.1), a definition of the current residence is already being applied. One could then define the preceding residence by the same criterion and determine whether there has been a change in the last 12 months. However, if a single-round survey is being used this procedure would give a biased estimate of migration in the last 12 months: since present residents are by definition those who have been living "here" for a minimum qualifying period (e.g. 6 months), immigrants who arrived more recently than this would be automatically excluded.

There seems to be no simple way of avoiding these difficulties without introducing artificial and complex criteria of migration. Thus, in a single round survey the question cannot hope to give anything more than very rough results. In a multi-round follow-up survey, on the other hand, it should give reliable data - see (d) below. The question is listed under "Other useful topics" in the ECA "African Recommendations for the 1970 Population Censuses".

(b) Place of residence at a fixed prior date

Questions on the place of residence one year, or in some cases five years, prior to the enumeration have been asked in censuses and surveys conducted in several countries of Europe, Asia and America; but they have rarely been tried in Africa. A question on place of residence at the time of independence (1 July 1962) was asked in the 1966 census of Algeria, and in the 1969 census of Zambia informants were asked where they had been living 12 months previously. In neither case, however, do the questions appear to have been very successful, though the reasons for these failures are not clear and may have been peculiar to the countries concerned. In view of the general lack of experience in Africa, questions of this type cannot merit a positive recommendation. But if the objectives of the survey include the determination of annual migration rates, and if such information cannot be obtained from other sources, a question on place of residence 12 months previously may well be worth trying. Certainly if the practical difficulties can be overcome this would be a particularly useful form in which to obtain the information.

(c) Follow-up method: movements since preceding survey round

Information on the movements of persons into and out of the sample areas between the rounds constitutes one of the principal by-products of the multi-round method: persons are reported to be there at one round and no longer there at the next, or people are found at a later round who were not there at the round before. Indeed the method constitutes the only really effective means of obtaining data on out-migration by means of a survey, particularly where such out-migration involves whole households and not just individuals. Once again, the dual record method should in principle be at least equally effective.

Migration questions with no fixed reference period

We consider in turn the following questions:

Birthplace
Place of origin or "home district"
Place of usual residence
Place of previous residence

Absent members of the household
Absent relatives.

These different questions suffer in varying degrees from the problems (i) to (vii) listed at the beginning of this section. We shall refer back to this list where convenient.

a) Birthplace

This is perhaps the commonest form of question for determining the general pattern of migration. For those born in the country, the question asks for the region (or whatever the largest geographical subdivision may be termed in the particular country); those born abroad are asked to state their country of birth. The coding difficulty - see (iii) above - is aggravated by the long time reference: geographical boundaries of regions, and even of countries, may have changed. The significance of the information obtained is further limited by two factors:

- The long reference period. The pattern of migration revealed relates to a period which varies considerably between individuals, averaging over 20 years. A breakdown of results by age is essential.

- Chance factors. A person's mother may have been in an abnormal place, such as a maternity hospital or her own mother's home, at the time of the birth.

(b) Place of origin or "home district"

This suffers from the same disadvantages as birthplace except that the "chance factors" mentioned above are practically eliminated. In some African countries the concept of a person's place of origin or home district is clear-cut; it is usually associated with his tribal affiliations, and he retains the idea of coming from a particular place of origin even though he may have lived most of his life away from it. The same concept can be applied to the country of origin of immigrants; indeed in some cases persons may be regarded as originating from a foreign country even though they were not born there: for example, in the 1960 census of Ghana, a person's country of origin was defined as the country where his father and/or paternal grandfather was born. There are some African countries, however, in which the "place of origin" concept is not meaningful for large parts of the population. The question needs careful testing in pilot studies.

It should also be observed that the value of questions either on birthplace or on place of origin will be considerably enhanced if they are asked in two or more consecutive censuses or surveys, since the comparison of the results from one census or survey to the next may enable the average annual migration rates during the interval to be estimated. For example in the case of Gambia (a country experiencing an appreciable net immigration), a question on birthplace was asked both in the census of 1963 and in that of 1973. The apparent increase in the numbers of persons born outside Gambia was used, after suitable allowance had been made for mortality, to estimate the annual net immigration into Gambia during the inter-censal decade.

(c) Place of usual residence

Questions of the type - "Do you live here, or somewhere else?" have been included in various censuses and surveys. Their primary purpose has been to classify people as residents or visitors with a view to identifying the de jure population (Section 4.1), but they also provide some information on short term migration. The principal problem involved is the definition of residence - see (iv) above.

(d) Place of previous residence

The main difficulty with this question is that we get only the most recent move from each informant. The further back in time we go, the longer the resulting bias since we miss increasing numbers of earlier moves by the more mobile people. A date cut-off must therefore be applied in the analysis - perhaps 3, 4 or 5 years back. This means dating the informant's latest move. The coding problem - (iii) above - is also present as usual, besides the problem of defining residence for persons who move frequently - (iv) above. In line with our earlier recommendation, one might define residence as the place in which the person lived most during the calendar year concerned. Clearly there are many complications and it must be faced that the results can only be very approximate.

It is, of course, possible to probe back in more detail and attempt to get a complete "migration history" from each individual, analogous to the pregnancy history described earlier. This would eliminate the bias mentioned above but at the expense of a far more complex interview and questionnaire. The problems of coding and the definition of residence are aggravated, while that of tabulation and presentation - (v) above - becomes particularly intractable. Moreover, recall lapse and difficulties of dating are likely to be serious.

(e) Absent members of the household

As we saw in Section 4.1, de jure enumeration requires a question on absent members of the household. This is a possible source of information on migration. In particular, in a single round survey it is the only way of getting information on emigration from the country. Note, however, that only temporary emigrants are likely to be reported: if a person has left for good, by definition he has ceased to be a member of the household. The difficulties arising from the break-up of households, noted above in connexion with deaths, are also relevant here (see section (a) under Current mortality above).

(f) Absent relatives

The alternative approach of asking every adult to give particulars of all his or her relatives currently outside the country was tried in the 1966 census of Malawi. The disadvantage of this method is that each absentee may be reported as many times as he has relatives. In a sample survey, this can only be corrected by reweighting each person by the reciprocal of the number of people who could have reported him. It is not practicable to get the latter information and the method is not recommended.

Migration: summary

(1) Migration questions present a variety of difficulties at all stages of the survey. These difficulties are particularly acute as regard urban areas.

(2) It should be accepted that any information obtained will be only very approximate.

(3) Skeleton tables should be drawn up in advance of the survey, showing the mode of analysis intended. The implications in terms of sampling error, question design and coding should be carefully considered.

(4) For current migration movements, the best information is likely to come from a multi-round survey. If, however, only a single round survey is available, a question on place of residence 12 months previously may be the most useful. Questions on birthplace or place of origin, if asked in a series of censuses or surveys, can also yield estimates of net annual migrants.

(5) For information on past movements, a question on place of origin is perhaps the most useful in most countries, but the question need careful testing in a pilot survey. If such tests show that the question is often misunderstood, a question on birthplace may be used.

(6) Some information on current and short-term movement can be picked up as a by-product of the questioning necessary for determining who is a member of the de jure population. In single round surveys this is also likely to be the only source of information on temporary emigrants abroad.

5.2 RELATED TOPICS

In this section we consider the following topics or items:

Date of interview
Name
Relationship
Marital status
Affiliation (ethnic, linguistic, religious, national)
Educational level
Economic characteristics
Housing

We also consider the inclusion of items which are designed to serve the purposes of subsequent surveys.

Each of these items may find a place in a demographic survey questionnaire for one or more of the following reasons:

(1) It may serve purposes of field control
(2) It may be needed to support or supplement the demographic analysis
(3) The information may be sought for its own sake
(4) It may be needed for matching purposes in a PGE operation.

The last three items listed at the beginning of this section are not strictly "demographic". If they are included in the survey because the information is sought for its own sake, then the survey is not purely demographic, in the narrow sense, but becomes multi-purpose. The study of these variables for their own sake takes us outside the field of this manual; in the present chapter they will be considered only as regards their relationship with the demographic survey proper. In particular, we shall examine their use for cross-tabulation against fertility and mortality - for example, with a view to determining whether educated women have more or fewer children than uneducated women. We shall consider also how the collection of information on these variables may come into conflict with the collection of the strictly demographic data. This, together with the problem of multi-purpose surveys, is taken up again in a note at the end of the chapter.

A. Date of interview

The problems of field control are treated in Chapter 9. Field control requires the inclusion in the questionnaire of a number of identification items such as house number, name of enumerator, etc. Among these, we single out here the date of interview only because, in certain circumstances, it may also be an essential item in the analysis. Thus in multi-round follow-up surveys the reference period is the interval between two rounds. This interval must be known exactly if the vital rates are to be computed. In the dual record method, the data may also be needed for matching purposes. These points are treated more fully in Chapter 11. In summary: date of interview is always needed for control purposes; it is also needed for analytical purposes in follow-up surveys and for matching purposes in dual record systems.

B. Name

The name of each individual is needed for field control purposes. It is also needed for matching in dual record systems.

Even in a single-round survey, names are essential for the mechanics of the interview. Interview procedures are discussed further in Chapter 9, where it is recommended that the enumerators should first concentrate on completing the list of household members, and then complete the particulars of each person's characteristics. Unless he has recorded each person's name in the first part of the operation, confusion and misunderstanding could clearly arise in the second. If, in addition, spot checks are to be made by the supervisor, or if the enumerators are to be required to re-visit the household when an error is detected, the names will be doubly indispensable, and they are of course essential in follow-up or dual record enquiries.

It seems very likely, also, that the recording of names leads to more complete enumeration. Asking the head of the household to name the members one by one should ensure more complete coverage than simply asking for the number of persons in the household - for the reasons given above in connexion with lifetime fertility.

Particularly where follow-up and matching are involved, it is important that the full name of the person should be recorded. Many persons have several names, and the distinction made in more developed countries between a person's official names, given at baptism or recorded when his birth is registered, and nick-names, acquired later in life, does not apply in many African communities. Thus many people may have both an African tribal name and a European-type name, possibly given on baptism. Confusion can often arise because a person is known locally by his tribal name, but gives the European-type name to the survey enumerator, who appears as a sophisticated person of superior education coming from the city.

Another difficulty sometimes missed by expatriates concerned with the design of surveys in Africa is that in many areas there is no real equivalent of the European "surname" which is handed down generation after generation, and which a wife takes from her husband on marriage. The questionnaire item should therefore be headed "FULL NAME" rather than "SURNAME".

Another reason for entering as many names as possible is that people in a given locality often share a common name. Thus in a recent survey in Malawi the "surname" given for 11 out of 20 household heads in one sampling area was Phiri.

Variations in spelling are another source of confusion: since the respondent is often illiterate, the enumerator will try to spell the name phonetically as he hears it. If the name is recorded twice by different enumerators (or once by an enumerator and again by a registrar) and the records have to be matched, the spellings will rarely agree. In some Asian dual record studies this difficulty has been tackled by the use of the "Soundex code" system. In Africa, however, the application of this system would often be vitiated by varying use of suffixes and prefixes: for example "Mtuma" becomes "Mtumanawo", or "Siliza" becomes "Naziliza".

C. Relationship

Most censuses and demographic surveys in Africa have included a question on relationship, which can be of value both because it opens the way to several checks of internal consistency and because of the information which it provides on household size and composition. It may also be used for matching purposes in a dual record system.

Two methods have been used in African surveys and censuses for recording relationship. In the first, only the relationship to the head of the household is given. In the second, the relationship is specified as simply as possible in relation to some person higher up on the list, using line numbers for identification. Thus, if the head appears on line 1 and his wife on

line 2, their son is entered as "Son of 1 & 2". In this method, if the relationship involves someone whose name does not appear in the household list he is referred to as x. 1/ An example is shown below.

METHOD 1		METHOD 2	
No.	Relation to Head	No.	Relationship
1	Head	1	Head
2	Wife	2	Wife of 1
3	Son	3	Son of 1 & 2
4	Son's wife	4	Wife of 3
5	Son's son	5	Son of 3 & 4
6	Wife's daughter	6	Daughter of 2 & x
7	Wife's daughter's son	7	Son of 6 & x
8	Visitor	8	Visitor
9	Visitor	9	Wife of 8

Note that in Method 2 the relationship is given with reference to a person higher in the list: No. 2 is entered as "Wife of 1", not as "Mother of 3".

Method 2 has several advantages:

(1) It gives more information and hence offers greater possibilities for consistency checking. For example, in Method 1, person No. 5 may be the son of No. 3 or he may be the son of another (absent) son of the Head; we cannot tell which. In Method 2, this uncertainty is eliminated. Similarly, in Method 1 we do not see that the visitor 9 is the wife of 8. An important feature of Method 2 is that it identifies both parents.

(2) Method 2 is easier to use, although it takes a little longer to learn. In Method 1 the descriptions sometimes become highly complicated and this can cause mistakes. For example, No. 7 appears more complex in Method 1 than Method 2.

(3) In Method 1, the enumerator may inadvertently record the relationship of the head to the person, instead of the relationship of the person to the head. If the head's father is in the household and the head says "I am his son", the enumerator may write "Son" as the entry where he should have written "Father". This mistake cannot easily happen with Method 2.

1/ It is simpler to allow x to be used repeatedly for every unknown or absent person rather than to insist on x for the first unknown, y for the second unknown in the household, z for the third, etc.. There are many minor variations of the system. In French-speaking countries "Son of 1 & 2" has usually been written "Fils de 1 X 2" and a dash is used instead of x.

(4) The linking of the mother and her children, which is an essential feature of Method 2, may enable estimates of age-specific fertility rates over the past decade to be reconstructed, using the "Own children" method of analysis. 1/ This method has not, at the time of writing, ever been used with African data, and the poor quality of most African age data may necessitate modifications of the technique. Its potentialities, however, should not go without mention.

Method 2 has been used successfully in many African surveys and is recommended.

Assuming that Method 2 is used, the following checks (among others) can be made:

(i) Relationship may be checked against sex: wives, daughters, mothers, etc. should be shown as female; sons, fathers, etc. as male.

(ii) The age of the parents (particularly mothers) may be checked against the age of their children. E.g. if the mother is shown as aged 18 and the child as 12, or the mother as 70 and the child as 2, a mistake has obviously been made.

(iii) Relationship can be checked against marital status. E.g. if a woman is shown as "Wife" under relationship, both she and her husband should be shown as "Married" under marital status.

(iv) The number of children borne by a woman and entered as "living at home" in the question on lifetime fertility may be checked against the individual names of her children entered in the questionnaire.

(v) If, in the fertility questions, a woman's last-born child is stated to be still alive and if the entry against children "living elsewhere" is nil, then the age of the youngest child of hers enumerated in the household can be checked against the date of her last live birth.

(vi) When a question on survival of parents is included in the questionnaire (see above), the answer can in many cases be checked against the household list.

These checks are in most cases valid only if the children shown as sons and daughters under relationship are the true biological offspring of the reported parents, and not adopted children. For this reason, enumerators have sometimes been instructed to specify "adopted son" or "adopted daughter" as appropriate. However it hardly seems reasonable to expect the enumerator to ask of every single child in the sample - "Is this child adopted?" The important point, rather, is to encourage enumerators themselves to look for

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1/ Lee-Jay Cho, "The own-children approach to fertility estimation: an elaboration", International Population Conference, Liège, 1973, Vol. 2.

contradictions of the sort mentioned above and to probe more carefully when they occur.

The usefulness of these checks depends largely on the point at which the incompatibilities are picked up. If they are spotted in the field by the enumerator himself or the supervisor, the appropriate corrections can generally be made; but if they are not found until the data are being processed it is usually difficult or impossible to tell where the error lies.

In most African censuses and surveys the item on relationship has been used only for control purposes. However, in a few cases the data have been analysed in order to obtain statistical information on household composition.

Such analyses are inevitably complex. It is necessary to classify households into types according to composition. The definitions of the types demands very careful thought and any scheme is inevitably arbitrary. Once a preliminary classification has been drawn up it should be tested on a sample of data relating to at least 100 households before it is considered as final: if this is not done there will certainly be unforeseen difficulties in application.

It is important to recall at this point that the concept of the "household" in almost all African societies is inevitably inexact (see Section 4.2). The survey planner must consider whether information of this kind is worth the considerable effort involved in the analysis. A decision to process or not to process the relationship data should be taken before the questionnaire is finalized.

D. Marital status

In many European, Asian and American populations, marriage is a variable of such fundamental demographic importance that it forms the corner-stone of the analysis of any fertility data obtained in censuses and surveys. It may therefore seem surprising to some to find the subject of marital status in this chapter under the heading of "related topics" rather than under "main demographic topics". In Africa, however, two important factors must be remembered: first, as regards the primary objective of most African demographic surveys - the determination of the rate of population growth - information on marital status is of only marginal utility; second, any thorough examination of the influence of marriage patterns on fertility involves both concepts which are difficult to define and questions which are difficult to answer.

Where a question on marital status has been included in most African censuses and demographic surveys, the information required has been a simple breakdown of the population into four categories: single (i.e. never married); married; widowed; divorced or separated.

The problem then arises of the definition of marriage. In most African countries one finds a whole range of marital situations varying both in their degree of permanence and in their relationship to law, religion and custom. Even if it is decided that all permanent unions are to be counted as marriages, there is still the question "how permanent?" How long should the couple have been living together to be counted as married? In fact further definitions

along these lines are unlikely to be of much value, and what happens in practice is that the enumerator leaves it to the respondents to decide whether they wish to be described as "married" or not. Reactions to the question may vary from one respondent to another, yet to dispute their answers may cause offence.

Information on marital status may be used for estimation of fertility and mortality in two ways.

(i) Using the proportion of women who are married in each five-year age group between the ages of 15 and 49, a simple model of the shape of the age-specific fertility distribution can be constructed. This model can be used either as a substitute for, or as a check on, data obtained from questions on births in the last 12 months or date of last birth. The model is only valid, however, for populations where births to unmarried women are negligibly few, and where birth control is not being practised. It could also be vitiated if there is a high incidence of venereal disease or other pathological disorders causing sterility at an early age. In many African populations the appropriate conditions are not met. 1/

(ii) The distribution of the population by age, sex and marital status can throw light on the age difference of husbands and wives, and this in turn leads to an estimate of the mean age of fathers at the birth of their children. This is an important parameter for the interpretation of data on survival of fathers (whose collection was recommended above). Such estimates will be subject to a wide margin of error. A more direct method would be to tabulate women bearing children in the last 12 months by age of husband (though this procedure is normally only feasible where the husband and wife are enumerated in the same household).

(iii) The proportions of persons widowed in each age group may, in some circumstances, be used to obtain indirect estimates of mortality for the opposite sex. In populations where an appreciable proportion of widowed persons re-marry, the straight question on marital status must be supplemented by additional questions as to whether or not ever-married persons had been married more than once, and if so, whether their first spouse was still alive.

In some African surveys enumerators have been required to record the form of marriage. In the 1960 Ghana post-enumeration survey, for example, marriages were recorded as customary only, customary and ordinance, church and ordinance, or other to be specified. In some cases customary marriage has been defined by the payment of bride-price, but in many countries this criterion would be meaningless since some "payment" passes in all marriages.

Several censuses and surveys in Africa have included questions for married men as to the number of their wives. This will provide data on the incidence of polygamy, which may be of value in its own right. But for the study of the relationship between polygamy and fertility, the question must be asked of the woman, not the man - i.e. whether her husband has another wife

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1/ United Nations, "Methods of Estimating Basic Demographic Measures from Incomplete Data", page 24.

If the question is restricted to the man only, the wives of polygamous husbands can only be recognized if they are enumerated in the same household as the husband, which is often not the case.

Again, the definition of polygamy hinges on the definition of marriage. Thus the situation often arises of the man who has a wife whom he leaves in charge of the agricultural holding and stock, and goes to the town in search of work. Having found a job and a place to live, he takes a mistress. Does this make him polygamous?

Information on marital status has been analysed in some surveys with a view to studying the relationship between age at marriage and fertility. This will normally require a question on age at first marriage, or on duration of marriage. (The latter will only give the age at first marriage if the current marriage is the respondent's first). Such questions are prone to all the difficulties and errors which affect questions involving dating in Africa.

The relationship between stability of marriage and fertility has also been a subject of study in some surveys. For this purpose, a question on current marital status is again not enough: we need to know not only that a woman is divorced now but how many times she has been divorced, or changed her conjugal partner, during her lifetime. Such information was collected, for example, in the demographic survey in West Cameroon (1964); here the routine collection of data from each woman on lifetime fertility was broken down in such a way as to record the number of children born in each separate marriage or union. This is the "marital history" method, analogous to the "pregnancy history" already discussed. Once again, there are the problems of dating, of age estimation and of the definition of marriage.

Summing up, marital status in African surveys is a topic of limited utility where the estimation of fertility and mortality is concerned; it also presents many practical difficulties of definition. But in any survey which attempts to go further, and which seeks to investigate the factors affecting fertility and the causes of fertility differentials, an examination of marriage patterns must take high priority. In these circumstances a single question on marital status is inadequate: additional questions on such aspects as the form of marriage, polygamy, age at marriage and stability of marriage are required.

E. Tribe, ethnic group, language, religion, nationality and citizenship

These characteristics often form the most significant sociological (and political) sub-divisions of the population. Information on them is often sought for its own sake, apart from any possible correlations with fertility and mortality. It should be noted, however, that they are characteristics which are subject to very high intra-class correlation (see below, chapter 7). As a result, if a sample survey aims to produce estimates of the absolute numbers of persons of each tribe, ethnic group, etc., such estimates will, in the absence of other supplementary data, be subject to relatively large sampling errors. In particular, data on nationality or citizenship, with the overwhelming majority of the population being nationals and only a small fraction foreigners, will be almost useless without supplementary information.

Where tribe and language are concerned, it is often desirable to combine the smaller units into broad groups, both in order to reduce the sampling errors mentioned above, and to simplify the processing and interpretation. This also applies where the data are used for cross-tabulation against fertility and mortality. If the tribal or language groups used for the cross-tabulation are too small, any differentials which may appear may not be statistically significant, quite apart from the fact that the tabulation and interpretation of the data for a large number of small groups would be expensive, time-consuming and laborious.

Cross-tabulations of tribal, ethnic or language groups by age, sex, fertility and mortality have an important advantage over such tabulations for geographical regions within the country - namely, that they are less affected by migration. On the assumption that a person retains his original tribal identity, and will report it correctly wherever he goes (an assumption which holds in most, but not all, parts of Africa) then the age-sex distribution from a given tribe within the country should be relatively migration-free, except of course for the effects of international migration. In contrast, the age-sex distributions of regions or districts may be considerably affected by internal migration. This fact is important where the estimation of fertility by the use of stable population models is concerned.

As regards language, the straight question "Can you speak (or understand) French/Swahili/Hausa ...?" is of very little value. Answers are liable to heavy bias dependent on the prestige of the language. To obtain reliable information on knowledge of languages a test is needed. The difficulties of administering a test in a survey situation are considerable (see next section on literacy tests) and there is some problem of evaluation of results; moreover, to operate the test the enumerator himself needs a minimal knowledge of the languages tested. This is not a suitable operation for inclusion in a routine large-sample demographic survey. In most surveys the language question has been limited to "What language do you speak in the home?" Even this may bring responses which are biased by considerations of prestige. In most countries such a question would add little useful information to the much simpler question on ethnic group, and where this is so the latter is recommended. However, political objections are sometimes raised to the inclusion of a question on tribe; where this is so the question on language spoken in the home may be useful as a more acceptable substitute.

F. Education

This is not strictly a demographic topic and will be considered here only superficially.

Questions relating to education which are commonly asked in censuses and surveys include the following:

(i) Literacy.

(ii) School attendance. Whether currently attending school full-time.

(iii) Educational attainment. Grade reached or completed, or number of years of full-time schooling.

(iv) Educational qualifications. Certificates, diplomas, degrees.

Questions on literacy have been asked in many censuses and surveys. However, they have often been shown to give unreliable results. Many persons claim to be able to read and write when they cannot. The questions are of little use unless backed by a test. Such tests have rarely been administered, though in the 1964 census of Botswana, for example, the enumerators did carry small cards with sentences printed on them in various languages which they were to ask the respondents to read. There are numerous difficulties in administering literacy tests in a survey. It is rare to be able to interview an informant in Africa without onlookers: if one of these can read it is almost impossible to keep him silent while the desired informant tries his best. Moreover, if the interviewee knows how to read the others will hear him and can then give the right answer when their turn comes. For this reason it is necessary to prepare several different cards and have enumerators use them in rotation. A basic difficulty is that the tests cannot be used for "informants" who are not interviewed: in most African surveys information for many persons comes by proxy from another member of the household. Finally, tests of this kind can test reading only; tests of writing are more inconvenient both to handle and to evaluate. For these reasons neither questions nor tests for literacy are recommended for routine demographic surveys.

Questions on school attendance may be asked as a check on current school enrolment statistics, or to determine what proportion of the "eligible" population (defined in terms of appropriate age-groups) is receiving schooling. However such a check is of limited value: if the two sources of data disagree the error is at least as likely to be in the survey as in the school enrolment reports.

If the survey includes a question on occupation (see G. below), then the item on school attendance is complementary (juveniles who are at school are outside the labour force) and may well be worth including to help the enumerator to get more accurate information. (Note, however, that if the survey is carried out, wholly or partly, during the vacation period following the end of the school year, the enumerator will need instructions regarding young people who are still uncertain whether they are going to continue their studies in the following school year - for example, because they have not received their examination results. It seems advisable to classify them as "students" rather than "unemployed".)

For purposes of cross-tabulation against fertility, the item on school attendance is of little value: the small number of children borne by girls currently attending school is of no demographic significance.

Questions on educational attainment are of value in their own right, as an indicator of the country's human resources, and for cross-tabulation with fertility. In practise the use of such questions is often complicated by the fact that systems of education - levels, standards, forms, grades - have been changed during the last ten or twenty years in many African countries. Thus a person who completed schooling twenty years ago may state a level for which there is no strict present-day equivalent. In countries where the system has changed, an equivalence table relating the old system with the new should be worked out in advance of the survey. A decision will then be needed as to the method of recording to be used by enumerators: when an answer is given

in the old system, should he record it as given or translate it directly into the new system? The best rule is perhaps to record the information exactly as given, but in that case the enumerator should be made familiar with the old system so that he can judge whether the information he has been given is adequate. A similar difficulty arises with persons educated abroad, but fortunately such cases are rare and the enumerator can be instructed to work out the equivalence in co-operation with the informant.

In countries where grade repetition is relatively infrequent a useful check question may be the year of leaving school. This leads to a check of the reported age against reported attainment.

Educational attainment should preferably be reported in terms of the highest grade successfully completed. Some respondents may wrongly report the grade attended rather than that completed: a supplementary check question is therefore needed on whether a grade examination was passed. Often no grade examination exists and in any case provision will have to be made for classifying those who are awaiting their examination results. Overstatement of attainment by one grade may be common as a result of these sources of error but the effect will hardly be significant if the data are analysed in broad groupings (see above).

A question on the number of years of full-time schooling is sometimes used to overcome the above difficulties. While the question is easier to analyse it is less meaningful: grade repetition is very common in Africa, and in many countries it is rare to find a pupil who has gone through the whole system without repeating a grade. The number of years of schooling is therefore a poor measure of attainment and is not recommended.

Despite the uncertainties mentioned above, questions on educational attainment give valuable information for cross-tabulation against fertility. For this purpose the woman's education should be tabulated against her lifetime fertility (total babies born alive), rather than current fertility, since the former is subject to much smaller sampling error and is free of dating error. In nearly all African countries women with secondary or higher education are rare, so that samples will be small. For this reason only broad educational groups should be used in the cross-tabulation.

Finally, as was mentioned in the sections above on fertility and mortality, questions on lifetime fertility generally provide information on the number of children who are still living and the number who have died. If these data are also cross-tabulated against education, differentials between education of the mother and the mortality of the children may also be investigated.

Questions on educational qualifications (leaving examinations, school certificate, etc.) have been asked in many surveys. They are of value in their own right provided the sample is very large. But in all African countries the possession of qualifications by women is too rare to justify cross-tabulation with fertility.

Survey planners are often asked by manpower specialists to include a question on possession of vocational qualifications. However, such qualifications are very infrequent in Africa, besides being highly clustered in geographical distribution. As a result, the relative sampling error for such data is likely to be extremely high and it is most unlikely that the information will serve any useful purpose.

Summing up: Literacy questions and tests are of very limited value. Questions on educational attainment are of value in their own right and for cross-tabulation against fertility. The most useful form of the question is that of "highest grade successfully completed". For cross-tabulation against fertility, use broad educational groups and lifetime fertility - the latter preferably broken down into surviving children and deceased. A question on current school attendance is of little value unless occupation is also being asked, when it may help by clarifying the status of juveniles. Questions on educational qualifications (general, not vocational) are of value in their own right but not, in Africa, for demographic analysis.

G. Economic characteristics

The items normally included under this heading are:

(i) Economic activity
(ii) Employment status
(iii) Occupation
(iv) Industry.

The definitions and classifications for these characteristics will be found in the ECA publication "African Recommendations for the 1970 Population Censuses". The subject takes us outside the scope of this manual. However, as a rough guide the following reminder may be useful:

Economic activity - means whether employed
unemployed
or not economically active (= mainly housewives and students)

Employment status - means whether employer
employee
own-account worker
or unpaid family worker

Occupation - means the type of work done.

Industry - refers to the activity of the establishment in which the person is employed.

In Africa there are many difficulties in practice in applying the international definitions. Particular difficulty is found in distinguishing own-account workers, unpaid family workers and housewives. The classification of women in rural areas is so uncertain that widely varying interpretations of the definitions have been made in different countries. In addition there are

always coding difficulties (a serious problem with this topic even in developed countries) due to incomplete descriptions; these are aggravated if it is decided to limit the topic to the single item "occupation" - the other items often provide needed clarification.

Altogether there are strong arguments against any attempt to obtain data on economic characteristics in a primarily demographic survey as defined for the purposes of this manual. This is not to decry the value of information on these topics in its own right; it is rather that, as has been stated in the Introduction, labour force and manpower surveys do not come within the terms of reference of this manual. To try to combine a labour force and a demographic survey in a single operation is inadvisable for various reasons:

(1) The cluster design which is appropriate for demographic variables (see Chapter 7) is highly inefficient for economic variables, whose intra-cluster correlation is very high.

(2) For labour force information, one would normally prefer a sample heavily weighted in favour of urban areas. This conflicts with the requirements of a demographic survey.

(3) Information on the labour force is needed for a complete 12-month period, seasonal variations being important in all countries. This may well conflict with the needs of the demographic survey.

(4) The economic items are complex and require much attention during the enumerators' training. They also take up a good deal of space in the questionnaire and require a large amount of labour at the coding stage. Despite all this, the results are inevitably subject to many sources of error and will always be only approximate.

If, despite these arguments, the economic questions are nevertheless retained, they may be usefully cross-tabulated against fertility. For this purpose, experience has shown that the most significant differentials are likely in respect of two attributes:

(i) Occupation of the husband, classified in broad groups (single-digit code) such as will roughly correlate with income and social status.

(ii) Employment status of the woman herself - i.e. whether or not she has a regular paid job.

Both these characteristics should again be cross-tabulated against the woman's lifetime fertility, rather than against current fertility.

H. Housing

This again is a non-demographic topic which is often included in demographic surveys. Any detailed discussion would take us outside the scope of this manual and reference should be made to the ECA "African Recommendations for the 1970 Housing Censuses".

Since many demographic surveys include as a first step a house-listing operation (see Section 9.4) it is tempting to argue that the house is already going to be an operational unit of the survey so that an enquiry on characteristics of housing can easily be fitted in. Unfortunately, this argument is not valid. The unit in terms of which a preliminary listing is required in demographic surveys should either be the address (i.e. one municipal house-number equals one unit), which serves to assist later identification, or else a unit of housing corresponding as closely as possible to what is currently occupied by one household. Neither of these units corresponds to the "housing unit" required for an adequate investigation of housing standards and defined in the United Nations recommendations. The reason for this is that the recommendations are designed specifically to make it possible for the enquiry to provide information on empty housing and on multi-occupancy (one housing unit occupied by more than one household). If housing is defined in terms of current occupancy, information on these topics will be obscured.

If an adequate survey of housing standards is to be made, therefore, a definition of the housing unit must be used which is independent of current occupancy. There will then be cases of more than one household in one housing unit and cases of one household in more than one housing unit. The complications this introduces for enumerators are very considerable and in practice enumerators are unlikely to follow the instructions laid down. When, in addition, it is appreciated that the definitions of both housing unit and household are inevitably imprecise in African applications, it will be seen that there are serious difficulties in any attept simply to attach a housing enquiry to a demographic survey.

Finally, to these difficulties should be added the fact that housing characteristics show very high intra-cluster correlations, both in urban and rural areas. In village after village, enumerators will be recording always the same responses: it is clearly wasteful to collect information in this way.

Items designed to serve subsequent surveys

As was mentioned in Chapter 1, demographic surveys in Africa are often used to provide a household sampling frame for subsequent surveys - particularly for agricultural and household budget surveys. In such cases the sample design for the second survey can generally be made more efficient by adding certain questions to the demographic survey. Examples of such questions are:

Whether the household has an agricultural holding

What crops the household operates

Whether the household sells any produce.

In many demographic surveys an important reason for inclusion of the questions on employment has been to provide supplementary information for the subsequent sampling operation.

Obviously this motive for adding to the questionnaire cannot be ignored: the demographer working within the government service cannot reasonably claim exclusive right to his survey. Nevertheless, every additional question of this kind complicates the work and threatens the value of all the data.

A decision between these conflicting claims in the case of a single ro survey is difficult indeed. However, one important advantage of multi-roun surveys is that the later rounds provide additional opportunities for colle ing non-demographic information. There may even be a positive advantage in including such items in a follow-up round: the enumerator who only has to check each person on the household list as living or dead and record arriva and departures is too easily tempted to skimp his work; but where he has a distinct new question to ask the obligation to carry out a careful intervie is more difficult to ignore.

5.3 SUMMARY AND RECOMMENDATIONS

The organizers of any demographic survey face a wide choice of topics for investigation and an even wider choice of means by which information on these topics may be collected. The selections which they eventually make will depend on several factors: the objectives of the survey, the type of survey operation (single-round, multi-round, or combined survey-registratio the resources, both human and financial, which are available, the peculiari of the population to be surveyed, and so on. Thus in some cases it has not been possible for us to make firm recommendations, but merely to point out advantages and disadvantages of the various possibilities.

However, it is possible to recommend a minimum list of questions to be included on the assumption, first that the objectives of the survey include the determination of the age-sex distribution of the country's population a its vital rates, and, second, that the sample will be approximately of the size and design recommended in Chapter 7. This minimum list is recommende for any type of demographic survey, whether single-round, multi-round or du record. In the case of multi-round and dual record operations the list may be taken as recommended for the first round.

The minimum list of questions is as follows:

(i) Questions to be asked of all persons:

- Name
- Relationship
- Sex
- Age in completed years
- Survival of parents

(ii) Questions to be asked of every adult woman:

- Number of children ever borne alive who are now living at home, by sex.
- Number of children ever borne alive who are now living elsewhe by sex.
- Number of children ever borne alive who have died, by sex.

- Date and sex of her most recent live birth.
- Whether or not this last live-born child is still alive.

(iii) Questions to be asked of each household:

- Births in the last 12 months, by sex and date of birth.
- Deaths in the last 12 months, by sex, age and date.

Second in priority, the following items are suggested:

Marital status

Birthplace or place of origin

Where labour emigration is important: absent members of the household outside the country, by sex and age.

Third in priority come:

Educational attainment

Economic characteristics

Housing characteristics.

These priorities are fixed in terms of the assumption that the primary objective of the survey is demographic in the narrow sense, so that the "third priority" variables, for example, would be intended for cross-tabulation against fertility and mortality. In a larger context, it may be that the national authorities in a particular situation would wish to give higher priority to study of economic characteristics as such. If this should be so we suggest, for reasons stated earlier, that a specially designed study of this area be prepared and given priority over the demographic survey. There are strong technical reasons against combining the two in a single survey.

It is not possible to fix a position in order of priority for the "affiliation" items - tribe, religion, etc. The value of such items can be judged only in relation to the special needs of the country concerned.

NOTE ON MULTI-PURPOSE SURVEYS

This note is added as a renewed plea for simplicity. Experience has shown all too often that the more questions are included in the questionnaire, the poorer will be the quality of all the results. A multi-purpose survey will not produce as good data on demography as a strictly demographic survey. Primarily this is because the overloading of the enumerators' training course leads to a higher rate of error in the field. But it is also because the questionnaire becomes more complex, the interview becomes longer and hence more fatiguing for both enumerator and respondent, and because all the subsequent operations, from coding to computer programming, become more elaborate. In addition, as we have seen, most of the non-demographic items clash in one way or another with the needs of the demographic survey - the sample design, whether in space or time, is inappropriate or the units are incompatible.

Once it is known that a survey is being planned, the organizers are often subjected to pressures from various directions to include additional items on subjects which have nothing to do with the original purposes of the survey. The organizers must know how to resist these pressures. When considering whether a question should be included, they should ask themselves, not so much - "Are we likely to need this information?" but rather - "Can we do without this information?" An ambitious questionnaire needs to be matched by unusually high quality field staff, meticulous training and close supervision in the field; if it is not, much of the data is likely to prove worthless.

References

United Nations (New York):

Principles and Recommendations for the 1970 Population Censuses (ST/STAT/Ser.M/44), 1967.

Methodology of Demographic Sample Surveys (ST/STAT/Ser.M/51), 1971.

Handbook of Population Census Methods 3 Vols. (ST/STAT/Ser.F/5/Rev.1), 1958-59.

Handbook of Household Surveys (ST/STAT/Ser.F/10), 1964.

Variables and Questionnaire for Comparative Fertility Surveys (ST/SOA/Ser.A/45), 1970.

Methods of Estimating Basic Demographic Measures from Incomplete Data (ST/SOA/Ser.A/42), 1967.

Methods of Measuring Internal Migration (ST/SOA/Ser.A/47), 1970.

United Nations Economic Commission for Africa (Addis Ababa):

African Recommendations for the 1970 Population Censuses (E/CN.14/CAS.5/CPH/9).

Methods and Problems of African Population Censuses and Surveys 1955-64 (E/CN.14/CAS.3/3/Rev.1), 1965.

Methods and Problems of Civil Registration and Vital Statistics Collection in Africa (E/CN.14/CAS.3/8), 1963.

The Collection of Migration Statistics in Africa (E/CN.14/CAS.4/CPH/6), 1965.

Report of the Seminar on the Organization and Conduct of Censuses of Population and Housing, 2 Vols., 1968.

Institut national de la statistique et des études économiques
Institut national d'études démographiques (Paris) :

Afrique Noire, Madagascar, Comores : Démographie comparée, 2 vols., 1967.

See also the references cited at the end of Chapter 12, many of which are also relevant to this chapter.

CHAPTER 6

DESIGN OF THE QUESTIONNAIRE

A. General

Once the content of the questionnaire has been fixed, work can begin on drawing up the document itself. This task immediately raises a large number of small problems, such as the language to be used, the lay-out, the method of reproduction, whether the questionnaires should be bound in booklets, the method of recording responses, and so on.

In the present chapter we offer recommendations, based on African experience, for dealing with each of these problems. The chapter ends with a specimen recommended questionnaire. It should be stressed that many of the recommendations depend on the circumstances of the survey - either the characteristics of the population surveyed or the method of data-processing which is planned.

The presentation in this chapter starts from the general and works towards the particular. We begin with the general basis and principle of the questionnaire, go on to consider lay-out and reproduction, then consider the questions themselves - language, presentation of questions, recording of answers. Finally we deal with the special case of the pregnancy history questionnaire. Some special problems arise with follow-up surveys and dual record systems (PGEs); these are treated in Chapter 11.

It is assumed throughout this chapter that the survey requires information to be recorded for individuals. Thus, we exclude without discussion the kind of group enumeration questionnaire in which the enumerator merely has to indicate how many persons of each sex, age-group, etc. are found, without particularizing them.

B. Basis of the questionnaire

From the start, a decision is needed whether to use one questionnaire per area, one per unit of housing, one per household, or one per person.

One per area saves paper, but in most respects it is inconvenient. The number of persons covered in any meaningful area unit is likely to run into hundreds. These cannot all go on one page. There will therefore be frequent turnovers in course of one questionnaire. This creates difficulties - see section C(4) below. In particular, the "relationship" question refers one person to another within the household: this becomes difficult to handle if the members of the household are not clearly grouped together on one page.

One questionnaire per unit of housing - whether house, compound or other unit - would be appropriate only where this unit is in fact used in the survey. It would involve unnecessary work if the enumerator had to learn how to identify such a unit simply for the sake of the organization of the questionnaire.

In most surveys where a housing unit is involved there will be a special housing questionnaire; it would be appropriate to arrange this questionnaire on the basis of one per housing unit, but not the demographic questionnaire. (We have already seen that one cannot assume any simple correspondence between the housing unit and the household.) An exceptional case is the demographic survey confined to a city such as Brazzaville or Kinshasa where the regular grid plan of the city leads to very clear units of housing ("parcelles" or lots). In such instances there may be a good case for using one questionnaire per lot.

One questionnaire per household is the commonest method and nearly always the most convenient. The household is the unit of interview; items of information for one household are inter-related and should be checked against one another; in many surveys there are items which relate to the household as a whole. For all these reasons it is convenient to use one questionnaire for each household.

One questionnaire per person is sometimes used where the questionnaire is too complex for information to be entered for several people on a single page. In demographic surveys this situation is likely to arise only for the pregnancy history questionnaire. Where individual questionnaires are used, the amount of paper to be handled by the enumerator is much greater and the instructions inevitably become more complex - partly because arrangements for relating individual questionnaires to group questionnaires have to be made, by appropriate serial numbering and referencing. This method is to be avoided if possible. 1/

C. Binding questionnaires into booklets. Linkage between documents

All questionnaires need to be clearly identified as to the area to which they relate. Some of the advantages of the method of one questionnaire per area can be achieved, without the disadvantages, by binding questionnaires into booklets and using one booklet per area. Where this is done, each sheet represents a household and the area information has to be entered only once, on the cover of the booklet. The sheets in the booklets should be pre-numbered.

Besides saving time in the writing of the area information, the method helps to reduce loss of questionnaires. A hard back should be provided to the booklet, otherwise the last few pages will be difficult to write on. (They will in any case if the questionnaire is very large and if the booklet contains too many sheets; it is advisable to experiment with dummies before making a printing order.)

The booklet method involves more wasted paper, since a new booklet must always be started in each new area unit (probably each enumerator's area).

1/ A possible exception to this general rule may be the case of a multi-round follow-up survey designed to continue for a large number of rounds. See discussion in Section 11.1 under Questionnaire design.

There is also a special difficulty where a follow-up is involved: households may appear and they have to be added out of series, probably at the end.

One serious drawback with booklets is illustrated by what happened in the 1960 census in Morocco. The booklet contained enough sheets for 97 households. The name of the douar (village) was to be entered on the cover. When the results of the census were processed it was found that a very large number of douars had exactly 97 households. Clearly, the douar being a unit of uncertain definition, many enumerators had continued filling the booklet until all pages were used up. When starting a new booklet they asked the name of the douar where they were by now working; but they did not consider this question while in the course of working within a given booklet. If booklets are used, very careful instructions are needed about when to start a fresh booklet, when to write "continued" on a booklet, and so on.

The balance of arguments for and against binding the questionnaires in booklets is thus fairly even. We are inclined to recommend in favour of booklets, at least for single-round surveys.

In most surveys some kind of questionnaire or form has to be completed which gives information about the whole enumerator's area. It is also common to have a "pre-listing" form (see Section 9.4) in which the households in the area are listed with the name of the head of household and the house number. (The latter may be a municipal house number or "address", or in rural areas it may be a number assigned by the enumerator who affixes numbered stickers to every house in a preliminary tour of the area - see again Section 9.4). Such area information forms and listing sheets are required on the basis of one per area. If the demographic questionnaires are bound in booklets, these forms can be included at the front; if not, arrangements must be made for linkage between forms, for example by providing space on each demographic questionnaire for the area number and the house number.

D. General principles of lay-out

Horizontal or vertical form

Two types of lay-out are possible for a demographic questionnaire which is designed to cover each individual in one household: the information for one individual can go across the page or down. We refer to these respectively as the horizontal and vertical forms of questionnaire. In the horizontal questionnaire the names appear one under another on the left-hand side (right-hand in Arabic questionnaires) and the question headings appear across the top. In the vertical form, the name is entered at the top of the column and each line is for one question.

The horizontal form has usually been preferred, the argument against the vertical form being as follows. In the vertical form the column must be as wide as the widest item required - probably the name. This means about 5 cm (2 inches). This column width is quite unnecessarily wide for the very simple items such as sex, age, marital status. There is therefore a waste of space, so that less information can be recorded on a sheet of given size with the vertical form than with the horizontal.

Another advantage of the horizontal form is that card punchers are accustomed to working across the page. However, a minor advantage of the vertical form is that the questions themselves are more easily fitted in.

The horizontal form is recommended and will be assumed in the rest of this manual.

Column width and spacing

If full advantage is to te taken of the flexibility offered by the horizontal form, the column width must be varied from question to question. The width should be decided by considering the space needed for recording answers - not the space needed for typing the heading. The heading can always be fitted in somehow - by using a smaller type-face, by typing up the page, by employing abbreviations; it is much more important not to cramp the enumerator recording the response.

More generally, it is essential that the lay-out be planned by the statistician or demographer responsible for the survey: if the lay-out is left to the typist or printer the column and line widths will certainly not be optimal. The survey planner should draw the framework of the questionnaire (the horizontal and vertical lines or "rules") with exactly the desired spacing; the typist or printer should then be instructed to fit the text into this frame.

Size of sheet

The size of the questionnaire is sometimes limited by available paper sizes. Whether this is so or not, the choice of size should take account of the convenience of the enumerator. Nearly always, he will have to work without a desk or table. A questionnaire that is too wide for convenience may have to be accepted; but a questionnaire that is also long from top to bottom may become unmanageable and in any case is unnecessary.

A reasonable maximum would be a width of 50 cms (20 inches) and a height (top to bottom) of 25 cms (10 inches).

The back of the page should not normally be used at all (except perhaps for enumerators' notes).

Serial numbering and "continuing"

For easy reference it is advisable to serial number the lines, or individuals. These numbers can be pre-printed down the left-hand side of the form (right-hand side in Arabic). Two-digit numbers should be used for convenience of punching: 01, 02, ... 09, 10, 11 .... (but see below for an alternative system).

As many lines as possible should be provided (within a format of given size) for members of the household. Between 10 and 15 is typical in African surveys. But however many are provided there will always be some households too large to be entered on one sheet. Some arrangements must therefore be made for continuing a household on another sheet.

In some surveys a special continuation sheet of a different colour has been used. However, this means more forms for the enumerator and it is probably simpler to use the standard form.

If booklets are used the questionnaires will already be numbered. Instructions to the enumerator can then be as follows:

> If you have to continue on a second sheet, write "CONTINUED ON PAGE..." at the foot of the first sheet, and write "CONTINUED FROM PAGE ..." at the top of the second sheet. Cross out the line serial numbers on the second sheet and write in new ones, beginning [ ]. 1/

If booklets are not used there is no page numbering. Enumerators will then merely write "CONTINUED" at the foot of the first page and "CONTINUATION" at the top of the second. Again they must also change the line serial numbers on the second page. If booklets are not used there will be spaces provided for geographical identification at the top of every questionnaire; the enumerator should be instructed to complete these as usual on the continuation questionnaires.

An alternative way of dealing with the serial numbering of individuals to allow for the case where the household runs onto two or more pages is as follows:

(1) Limit the questionnaire to 10 lines.

(2) Number the lines with single digit serial numbers printed in the margin, the last line being numbered 0 instead of 10 (see model questionnaire at the end of this chapter).

(3) Instruct the enumerator to insert the digit 1 on the left of each number when using a 1st continuation sheet for a household, or the digit 2 if he is using a 2nd continuation, and so on.

This method has one defect: it forces us to print just 10 lines per page. Depending on lay-out considerations, one might well wish to print more than this in order to minimize the use of continuation pages.

The top line of every questionnaire is normally used for the head of the household, but this will not be so on the continuation sheet. In some surveys the word HEAD has been printed in the top line in the column for "Relationship"; however, this causes confusion in case of continuation and is better avoided. In any case the enumerator must be made to understand that, where a second sheet is used for continuation, the relationships recorded in the second sheet may refer back to the first: he must not imagine that because he uses two sheets he has split the household into two households.

1/ If there are 15 lines on a sheet, the instruction here would read "16", and so on.

E. Method of reproduction

The questionnaire is going to be used in tens of thousands of copies. It is worth spending a good deal of time to produce a document that is as clear and easy to use as it possibly can be. Generally this cannot be done with a standard typewriter, stencils and a duplicator.

In almost any country some more sophisticated means of reproduction is available. Scores of such systems are on the market, ranging from the "Varityper" to letter-press printing. It is not practicable to describe them all here; the questionnaire designer will have to use what is available. Two characteristics are essential: the system should be one which allows different type sizes within the same document, and it must be able to accommodate paper of the desired format and quality. When he has chosen a suitable and available process, the questionnaire designer must expect to have to spend a few hours studying its characteristics and experimenting with different type faces and type sizes before finalizing his lay-out.

Paper for the questionnaires should be reasonably tough but not unnecessarily heavy and must have a surface which takes writing with a ball-point pen. The availability of sufficient paper of the right quality and size should be checked at an early stage of the survey planning.

It may be noted that printing of questionnaires is often a bottleneck and there may be long delays, especially if letter-press printing (i.e. traditional printing) is used. In most countries the government printer seems to have a long backlog of work and needs many months' advance booking. Once again, this whole question of documents reproduction is one that should be looked into during the early stages of planning of the survey.

F. Language

In some African countries a single African language is widely known and used as a lingua franca (e.g. Swahili). In others, one of the "world" languages is the only widely known medium (Arabic, English, French). But in most countries there is not a single language that is sufficiently widespread to be used for interviewing in all regions of the country. The position varies from country to country and is generally well known to those planning a survey, so that no useful information can be given in this manual.

Ideally, the language of the questionnaire should be that in which the interview is to take place, but in many African countries this is hardly practicable, both because an excessively large number of language versions would be needed and because enumerators have not been educated to read a African languages even when they can speak them. It is mainly for this latter reason that the majority of questionnaires in African surveys are still in English or French, or at least bilingual with one of these languages included (e.g. Arabic-French; Swahili-English). 1/

1/ Questionnaires printed in local languages are, however, quite widely used in small surveys organized by some African universities. The World Fertility Survey is experimenting with their use in large-scale surveys covering multi-lingual populations. It is possible that within a few years the traditional African questionnaire printed in English or French will become a rarity.

It is worth stressing here that the language problem is often taken too lightly by African survey planners: if the enumerator is left to work out his own translation of the question mistakes are likely to arise and in some cases the resulting error may be important. Translations should therefore be worked out, before the survey starts, into all the main languages likely to be used. If these translations are not to be printed on the questionnaire the enumerators should be carefully coached in them during the training sessions. Note that this applies not only to the questions themselves but also to qualifying phrases. The important phrase "during the last 12 months" for example, is not always easy to translate and needs careful attention. 1/

G. Presentation of questions

In social and attitude surveys, interviewers are expected to follow the exact wording specified by the survey designer. In demographic surveys it is usually considered that the questions are so simple and factual in nature that the wording does not matter much. This is probably true for most of the items; nevertheless it is desirable, within reason, to have the actual questions appear on the questionnaire rather than abbreviated headings, except where the concept is extremely simple. A recommended example of the presentation of fertility questions is shown below.

ASK ALL FEMALES AGED 14 OR OVER

Of the total number of children borne alive by you in your whole life ...					
How many are now in this household ?		How many are now living elsewhere ?		How many have died?	
M	F	M	F	M	F

For other examples see the recommended questionnaire at the end of this chapter.

In presenting the material in the questionnaire a good working hypothesis is that once the enumerator has completed his training he will not look at his instructional manual any more - even if he has been firmly told to do so. Everything of real importance should therefore appear on the questionnaire itself: questions, significant limitations, the meaning of any codes to be used, instructions as to the persons to be covered, etc..

1/ In one African survey this concept had been rendered in the English version by "since the last dry season", whereas the Swahili version of the questionnaire gave "mwaka huu"" (this year). The meanings differ significantly and the error could be important.

In any demographic surveys there are likely to be categories of persons to whom certain questions do not apply. For example, information on fertility is required only of adult females; information on marital status is not needed for children; information on visitors may be limited to name, relationship, sex and age. In making provision for these special cases, simplicity should be the main consideration. Rather than provide special tables or boxes for the special cases, the simplest procedure is to have all persons reported in the same table and to print above the columns the necessary instructions showing who is covered. (Such instructions should be in a different type-face from the questions.) The example just given illustrates this method. In very simple cases, such as the marital status of children, the simplest solution is to make no special provision whatever: children will then be entered as S (single) under marital status. This is no more difficult than writing a dash and just as useful.

H. Method of recording responses

Numerous methods of recording answers have been used in surveys. The many variations are aimed at simplifying the work of the enumerators, card-punchers or computer programmers or at eliminating the operation of coding in the office by having the enumerator record the answers in coded form.

It is important to appreciate that the enumerator has to work under very unfavourable conditions compared with office workers. He rarely has a flat horizontal surface on which to lay the questionnaire; often the light is bad; he is surrounded by chattering spectators; he may have to translate the questions and answers; and finally his work is more complex than the mechanical job of the coder or puncher. He is therefore far more likely to make mistakes. Worse still, his work cannot be systematically checked, whereas that of coders and punchers can be.

In designing the questionnaire, therefore, first priority should be given to making the task easy for the enumerator. If this involves additional office work it should be accepted; in most cases the cost will be small and in any case the increased accuracy will pay off.

We now consider some possible recording methods in detail. Five different methods are shown below.

1)

Sex
M or F
M
M
F

2)

Sex	
M	F
x	
x	
	x

3)

Sex	
M	F
(1)	2
(1)	2
1	(2)

4)

Sex
1=male
2=female
1
1
2

5)

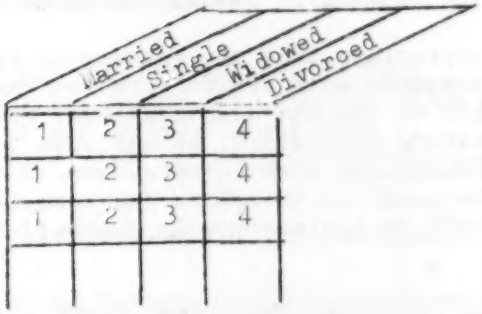
Sex	
Male	[x] 1
Female	[ ] 2
Male	[x] 1
Female	[ ] 2
Male	[ ] 1
Female	[x] 2

Method 1) is certainly the easiest for the enumerator and the least likely to lead to error. If mechanical equipment is being used for data-processing a coding operation will be needed to translate the letters into numbers. If electronic data processing is used the letters can be punched as they are (alpha-punching) and no coding is necessary. If Fortran is being used as the programming language the alpha-punching causes some trouble but it can be overcome. The best solution is to accept the alpha-punched input and include in the programme an operation to replace the letters by digits. (In other words coding is performed by the computer).

Comparing Methods 2) and 3), Method 3) can be punched directly whereas Method 2) cannot. For this reason, 3) is preferable and 2) should be ruled out.

There is little to chose between 3) and 4). A slip in following the column down in 3) is perhaps about as likely as a coding slip in 4). Both methods can be readily adapted to a more complex question having several codes. For example, 3) can be adapted as below:

MARITAL STATUS



The slanted headings can be read without turning the page. However, slips when following the heading into the column are likely to be common. 1/

Method 5) is the only one which combines the two advantages: (1) the enumerator enters the answer immediately against the word chosen, thus minimizing error, and (2) no coding operation is needed. On the other hand Method 5) takes up an excessive amount of space on the form and if there are a large number of such boxes the questionnaire will look cluttered and complicated. Certainly for such a simple item as sex this method seems excessively heavy-handed.

1/ University-educated statisticians do not always appreciate that those who have a very limited education and little familiarity with books and papers often find it very much more difficult to follow lines across and down pages without error.

Summing up: Method 1) is recommended, with alpha-punching. If this is not accepted Method 4) is perhaps the next best.

If questions are to be asked on such topics as occupation, or if the "relationship" data are to be processed, a coding operation in the office will certainly be needed. If office coding is to be involved, should coding boxes be provided? There seems to be no good argument for these. They clutter up the questionnaire and are unncessary. The best method of coding is to use a felt-tipped pen in a distinctive colour, such as red, and to write the code within the space provided for the enumerator's entry. There is nearly always some empty space left; even if there is not, the code is always easy to read even when written over the enumerator's own entry: the distinctive colour ensures this. (Note, however, that with some types of pen and certain papers the felt tip entries soak through the paper and stain the sheet underneath, and this may occasionally efface an entry. The pens and paper should be tested for this before coding is started.)

Various facilities are on the market which in theory enable the enumerator's record to be processed directly, without coding or punching. (Mark sensing; optical reader; etc.) While these have certain advantages, they have not been developed to the point where they can be conveniently used by the enumerator at an interview. They are discussed more fully in Chapter 10.

I. Reporting responses: some special cases

Age

The instructions generally require that ages under 2 years be recorded in months. How should this be entered? Perhaps the simplest method is the following:

A G E	
Completed years	Months if under 2 yrs

An entry is to be made in one column or the other, but not both. (It must be stressed to the enumerator that entries are to be made entirely in years or entirely in months, never in years and months.) This method requires 4 columns on the punch-card. Methods using 3 columns are possible, 2 for the age and 1 to distinguish whether the figure relates to years or months, but with these methods the likelihood of error is somewhat greater.

Relationship

Refer to Chapter 5, Section 5.2 C.

Not applicable and zero entries

As we have noted above there will often be questions which do not apply to certain persons. It is advisable not to permit blanks: this makes it easier to check for questions accidentally omitted. The best procedure for indicating "not applicable" is to draw a continuous horizontal line through the questions concerned.

As to zeros, for clarity it is best to indicate these always with the figure 0 and not with a dash.

J. Internal checks: duplication of information

In some African questionnaires, names have been listed once to provide a household membership list and then entered again in the table for individual characteristics. Again, in the question which asks for the number of children ever borne, classified by living in the home, living elsewhere, and dead, one sometimes sees a total column which is supposed to agree with the sum of the three entries mentioned.

This kind of duplication is of little value and should be avoided. It does not provide a check because in practice the enumerator is likely to complete one entry to agree with the other, whether right or wrong. Moreover, if the two entries do disagree there is still no way of telling which is correct without a follow-up field visit.

Checks of one item against another may be useful when both items are in fact needed for the survey, but it is seldom helpful to introduce a new item for the sole purpose of checking an existing one.

K. Need for simplicity

Examination of census and survey questionnaires used in the past reveals that many are quite unnecessarily complex. Often the information is collected in several distinct tables where one would suffice. Coding boxes appear in large numbers, making the questionnaire look cluttered and difficult. In many cases headings are unnecessarily elaborate.

In one African census schedule the following appears above the column headed "Religion",

> The religious community to which you belong must be clearly specified according to the annexed notes which should be consulted

Since "religion" already appears as the heading, all this could quite well be replaced by two words: "See notes". Similarly one often sees such instructions as:

Write M
for male
or F for
female

whereas under the heading "Sex" a sufficient instruction is simply:

M or F

Conversely, in column headings one sometimes sees abbreviations where there is plenty of space and no abbreviation is necessary. No doubt the abbreviation was carried over from an early draft of the questionnaire in which it appeared necessary.

All of these errors come from a lack of sufficient attention to detail in drawing up the questionnaire. The questionnaire plays such a key role in the survey that it deserves the most careful attention at the planning stage. Every word should be scrutinized to see if it can be eliminated in the interests of simplicity; every space should be examined to make sure it is of optimal size. When the first proofs come back from the printers a further minute examination should be made to ensure that there are no errors and that the lay-out is still appropriate in every detail.

L. Pregnancy or maternity history questionnaire

This questionnaire has been used in some surveys in order to allow for a more intensive questioning of adult women; it is argued that if women are asked merely to quote the number of babies to whom they have given birth, without particularizing them, the response will be superficial and inaccurate. The pregnancy history also provides some valuable additional data. (See Chapter 5, Section 5.1 C. Note however that the method is not firmly recommended in this manual.)

The method involves one questionnaire per person. The problem of lay-out is difficult because, essentially, we wish to establish the pregnancies and their outcomes in chronological order, yet the order in which the information comes to light during the interview may not be chronological. One of the purposes of the method is to show up unusual gaps in the sequence of reported pregnancies; the enumerator then draws attention to such gaps and it is hoped that he may thereby bring to light pregnancies which would otherwise be omitted. A method of recording is therefore needed which shows the chronological order clearly yet allows entries to be made as and when they are mentioned.

The method usually recommended (Bogue questionnaire) is to provide a large number of horizontal lines - perhaps 50 are needed for African populations - of which every fifth is marked with a cross (or a double line). The enumerator then enters first the births of children who are still living.

These entries are recorded on the marked lines only, beginning with the latest (some authorities prefer to begin with the earliest). Other pregnancies are then entered in the spaces between the marked lines, in accordance with their chronological position.

MODEL QUESTIONNAIRE

A model questionnaire is shown on the next page.

The questionnaire assumes comprehensive enumeration, i.e. covering both the de jure and the de facto population. Two questions are included to enable the two populations to be sorted out at the data processing stage (columns 4 and 5).

The questionnaire follows the minimum list of questions given at the end of Chapter 5, except for the addition of the two items mentioned above and the questions on tribe and place of origin.

Note that the references to "last Sunday night" might well be replaced by "last night" if this appears appropriate - see discussion in Section 4.1.

The model is reproduced here in the actual size.

C O N F I D E N T I A L

Name of District	
Name of Village	
P.S.U. No. →	
House No. (from sticker)	
Household No. →	

[NAME OF COUNTRY]

DEMOGRAPHIC SURVEY

CENTRAL OFFICE OF STATISTICS

BIRTHS to members of the household during the last 24 months	Name or line No. of MOTHER	SEX of child	DATE of birth

DEATHS of members of the household during the last 24 months	Name of deceased	SEX	AGE	DATE of death

LIST BELOW:

First all household members, present or absent
Then any other persons who slept last Sunday night in household

Today's date: _____ Last Sunday's date: _____

	Full name	Relationship	Sex M or F	Was he in this household more than any other place in last 12 months? YES or NO	Was he in this household last Sunday night? YES or NO	Age (Enter est. 6 or est. 7, NOT both) Completed years	Age Months if under 2 years	Marital status	Tribe	Place of origin PROVINCE only	Is father alive? YES or NO	Is mother alive? YES or NO	ASK ALL FEMALES AGED 14 OR OVER: Of all the children borne alive by you in your whole life ... How many are now in this household? M	F	How many are now living elsewhere? M	F	How many have died? M	F	Of your most recent live birth... Date of birth Year	Month	Child still alive? YES or NO
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19a)	(19b)	(21)
1																					
2																					
3																					
4																					
5																					
6																					
7																					
8																					
9																					
0																					

SUPERVISOR'S CHECK

Form checked in office	☐
Interview watched	☐
Re-interviewed	☐

Supervisor's Signature _____

Date _____

Enumerator's Signature _____

are only slightly more likely to be similar than households in separate villages. This is true of fertility and to a lesser extent of mortality. 1/ For clustered variables the optimal size of area units for efficient sampling is small; for less clustered variables it is larger.

Several studies carried out in West Africa suggest that for vital rates the optimum size of the sample that should be selected in each area unit is between two and four hundred persons. The smaller figure would be more appropriate where there is only one enumerator per area unit; the larger figure would apply if enumerators work together in teams of about 5 (see Annex 2). It will be suggested in Section 7.2 that the best method of sampling is to select all the persons in each selected area unit. From this it follows that the optimum size of area units is also from two to four hundred persons, at least for estimation of vital rates.

An African country planning a new survey may either take these conclusions as given or, better, compute the optimum afresh starting from local data and local assumptions about costs. The method of computation is described in Annex 2 of this manual. Essentially the steps are:

(1) An analysis of variance within and between area units, based on past data, leading to computation of the intra-cluster correlation.

(2) Assumption of a function relating costs within and between area units.

(3) Computation of the optimum number of households to be selected per area unit. Assuming the survey covers all households in the selected units, the above number is equivalent to the optimum number of households in the area unit - that is, the optimum size of area units.

In the remainder of this chapter we assume optimal values determined in this way from census and survey data in Cameroon, Chad, Ghana and Nigeria.

Based on the data of the Ghana 1960 census, demographic variables such as age and sex show about the same degree of clustering as the vital rates, so that the above optimum would still be acceptable for these variables.

1/ The degree of clustering may be measured by the intra-cluster (or intra-class) correlation, usually denoted by ρ or δ. This measures how much of the between-cluster variance is unaccounted for by the within-cluster variance, the difference being expressed as a proportion of total variance. For clusters of fixed size n,

$$\rho = \delta = (\sigma_b^2 - \frac{1}{n-1}\sigma_w^2) / (\sigma_b^2 + \sigma_w^2)$$

where σ_b^2 and σ_w^2 are the between- and within-cluster variances respectively. For fuller details, see Annex 2.

For education the clustering is greater and for employment characteristics much greater; for these variables the optimum area unit would be smaller. However it is impossible to optimize for all variables together. The most reasonable policy seems to be to optimize for the vital rates, which are the most important demographic variables.

Cost efficiency decreases only very slowly as we move away from the optimum. For example, if the optimum is at 300 persons, then the cost for given sampling error would be only about 12 per cent higher if we used clusters of twice the optimal size, and 31 per cent higher if we went to three times the optimal size. 1/ Moreover there are wide uncertainties in such estimates, both because we cannot be sure of the degree of clustering in advance of the survey and because the cost function can only be estimated very roughly.

Taking all this into account it is reasonable to seek area units of a few hundred population, but to allow a good deal of leeway. One thousand population should perhaps be taken as a maximum for an area unit.

In many African countries a sampling frame of area units exists in which nearly all of the units are of less than 1 000 population. In particular, the administrative census list of villages in French-speaking countries usually provides such a frame.

Units which are too large

It sometimes happens that most of the units are small enough but there are a few which exceed the limit. In other countries, most of the units will exceed the limit. In either case a decision has to be taken: either to accept the loss in cost efficiency resulting from excessively large units, or to break down the large units in some way. Either solution will involve additional cost. The second solution needs some further discussion.

Breaking down of larger units can be performed after sampling, so that only the selected large units need to be treated.

There are two methods of breaking them down:

(1) Creation of smaller area units. The area unit is visited by a field team and divided into two or more sub-units. The dividing lines must be clearly described or shown on a map. The new units should be made of very roughly the optimal size (i.e. a few hundred population), but more important than this is that the boundaries should be clearly defined. One of these sub-units is then selected at random. 2/

1/ Based on the assumption of a constant intra-cluster correlation of 0.002 and the cost function defined in Annex 2. See Annex 2 for a general formula relating cluster size to cost efficiency.

2/ In some cases more than one might be selected: see page 103 (note A).

(2) Subsampling of houses or households within the area unit. Every 2nd household or house (or every 3rd, etc.) is selected for the survey. The interval (2nd, 3rd, etc.) is chosen in advance for the particular area unit concerned, on the basis that it should yield very roughly the optimum size sample in the area unit. (Example: if the area unit is thought to have about 1 000 population and the optimum is thought to be 300, then select every 3rd). This method requires close supervision: the enumerator should not be left to carry out his own sampling. A list of houses or households should first be made and the sample then selected from the list.

In choosing between these two methods the following advantages and disadvantages should be noted:

Method (1) is simpler to describe to enumerators, involves less work and requires less supervision. (Note, however, that as in method (2) the selection of the sample sub-unit should not be left to the enumerator himself.) Nevertheless it will probably be found that creation of sub-units presents more difficulty than had been expected.

Method (2) is more efficient as a sample. We have already mentioned that "concurrent sampling" should be avoided (that is selection by the enumerator as he makes his interviewing round). Thus both methods require a special field operation in the area before interviewing starts.

Note A. If estimation of total population is one of the purposes of the survey, a new factor enters. In method (2) the proportion of the population of the area unit covered in the sample is known fairly accurately (if we select every 2nd household then we will get half of the population, to a fairly high degree of accuracy). This is not so in method (1): if we create two sub-units they will not normally account for half of the population each, even approximately. This fact gives method (1) a much larger sampling error than method (2) when we come to raise to a total population estimate. If many area units are going to be split in this way, the additional error in method (1) would be unacceptable. One way of reducing it would be to count the number of households (or perhaps houses) in (a) the whole area unit and (b) the selected sub-unit, and to use the ratio (a)/(b) for raising. This shoudd make method (1) almost as efficient as method (2) but the advantage of the simplicity of method (1) will have been largely lost.

Note B. As will be explained in Section 7.2, for a follow-up survey method (2) causes intractable problems of identifying households for follow-up and should be definitely excluded.

A choice now has to be made between methods 1 and 2 or, thirdly, leaving the large area units as they are despite the increased cost which this involves. It is important to note that, of these three alternatives, method (1) will suffer from the special disadvantage mentioned in note A above if both of the following apply:

(a) Estimation of total population is an objective

and (b) A substantial proportion of the area units are to be split.

On the other hand, method (2) should be definitely avoided if:

(c) The survey involves follow-up rounds.

The choice between the three alternatives cannot be made in this manual; it must be left to the responsibility of the survey planner. Account should be taken of all the factors mentioned above and of the numerous advantages of cluster sampling mentioned in Section 7.2 below.

Units which are too small

Area units which are much smaller than the optimum involve a loss in cost efficiency just like those that are larger. If, for example, the optimal size is 300 population, then acdeptance of a unit of size 100 involves a 31 per cent increase in cost for given error. 1/

The solution is to group such units with neighbours. This grouping has to be performed on the sampling frame list before sampling. It is assumed that there is some indication of the size of each unit in the list used as a sampling frame.

Sometimes the list does not show which area units are neighbours and no map is available. In this case the best solution is probably to group the small unit with any unit in the same district; the units grouped together do not have to be neighbours. If there is no indication whatever of location of units within the district, then one can group with a unit chosen so as to make the new unit of optimal size. Again, such grouping must be done before sampling.

An alternative is to have the grouping performed by district or provincial authorities. While grouping may appear a large and laborious operation it should be remembered that it serves the purpose of future surveys and not merely of the survey under immediate consideration.

In some countries area units of very small population have been excluded altogether from the survey, on the grounds that they are very costly to survey and account for a negligible fraction of the population of the country. As regards estimation of rates, averages and proportions this seems a reasonable policy provided such units are in fact known to cover a small fraction (say under 5 per cent) of the population. For estimation of totals the procedure would appear to be justified if supplementary information (such as "administrative census" data) is available on all units, which can be used to adjust for the missing units.

Boundaries of area units

For rigorous sampling, the boundaries between the units must be clearly defined. Unfortunately, in most developing countries the boundaries of the areas available as sampling units are not always well defined.

1/ Same assumptions as in footnote 1, page 95.

Where an area is ill defined, the enumerator who is called upon to survey it must make a decision on his own initiative or report his doubt to a superior. Where he makes his own decision, the average of such decisions is likely to be biased; for example, in doubtful cases enumerators are likely systematically to enumerate less than the full area. Even if the supervisor makes the decision one cannot be certain of eliminating bias.

The importance of this error depends crucially on whether the objectives of the survey include estimation of total population (or total in particular categories) or whether the survey aims to estimate only rates, proportions and averages. If the enumerator covers X % less than the correct area, then total population will be under-estimated by X %. However, for rates, proportions and averages, this error will appear both in the numerator and the denominator and will approximately cancel. There may be a small bias due to the fact that the excluded X % of the population are likely to come from outlying areas, and thus to have slightly different demographic characteristics, but this will not be comparable with the gross bias affecting the total population estimate and can probably be safely ignored.

If estimation of total population is an objective the question of boundaries of area units should be looked at very carefully. On-the-spot examination of a sample of area units in the field by the statistician responsible for the survey should be considered an essential preliminary. If it is found that the danger of bias is serious it may be better to eliminate altogether from the survey objectives any attempt to estimate total population.

7.2 TYPE OF SAMPLE

Cluster sampling

In this manual the term "cluster sampling" is used to mean complete coverage of the area units - i.e. without any sampling of dwellings or households within area units. 1/

We have already mentioned that cluster sampling is recommended for demographic surveys. The advantages are as follows:

(1) If there is sampling of dwellings or households within area units, then a list of dwellings or households has to be made. Such a listing operation involves visiting every household. If this has to be done in any case, it is more efficient to take advantage of this visit by carrying out the demographic interview at the same time, and in this case the additional cost of interviewing all households, instead of a sample, is very small. If a sample is to be selected then two visits must be made to the selected households.

1/ The term "cluster sampling" is sometimes used to refer simply to two or more stage sampling.

(2) The sub-sampling operation within the selected area units requires instructions and training and a certain amount of time (the work would normally be performed by a field supervisor); it also provides one additional opening for error.

(3) In Africa, the "household" is usually difficult to define and its membership varies rapidly. This causes uncertainty, and hence error, when the household is used as a sampling unit.

(4) Any arrangement which involves interviewing a high proportion of villagers but not all of them is liable to cause embarrassment in the field. Those who are not selected want to know why and may insist on an interview.

(5) If all households in a village are covered, there is more opportunity for getting information from neighbours about births and deaths occurring in households which are temporarily absent. It is also easier to eliminate double counting of deaths due to reporting of the same death by more than one household.

(6) Finally, in a follow-up survey the advantages of cluster sampling are overwhelming. In such a survey the households selected in the sample have to be identified clearly at one round for the benefit of the enumerator who is going to carry out later rounds. If there is any sampling of households, or even of dwellings, this will cause much difficulty due to the high mobility of the population and lack of addresses in most African areas. The only satisfactory basis for defining the sample is an area basis; the enumerator can then be told: "Interview all households within the given area".

These advantages of cluster sampling have to be set off against the loss of sampling efficiency involved. As we have seen in Section 7.1, the optimum sample size within each area unit is probably between 200 and 400. We suggested that the method of cluster sampling should be maintained even if the units go up to 1 000 population, but beyond this size one should carefully consider the alternatives of (1) dividing the area unit into sub-units or (2) sampling of dwellings or households within the selected area unit. The arguments for and against these alternatives have been presented in Section 7.1.

Multi-stage area sampling

The recommended unit size of a few hundred population corresponds to about one week's work by an enumerator. Assuming that enumerators are to work full-time on the survey, and that the whole survey will not be completed in one week, it follows that enumerators will be required to move from one area unit to another. In a large country the cost of such travel might be excessive and it may be profitable to use a 2-stage area sample: for example, first a sample of districts would be chosen, equal in number to the number of enumerators; then a sample of small area units would be selected in each selected district. If this is done, it is recommended to select the primary sampling units (PSUs) with probability proportional to size (census population) and then in each PSU to select the secondary sampling units (SSUs) with probability proportional to the reciprocal of the primary stage probability. This

will give equal overall selection probabilities for all SSUs. Methods of making such selections are described in sampling textbooks (see references at the end of this chapter).

Fixed or varying sampling fractions

In general, varying sampling fractions may be used in sampling for any of three reasons:

(1) To take advantage of supplementary information on the size of units (sampling with probability proportional to size);

(2) To distribute the sample with maximum cost-efficiency by taking into account the differing levels of variability and costs in different strata;

(3) To ensure an adequate sample in certain reporting domains which are important but small (for example, the urban sector).

For African demographic surveys, the strategies under (1) and (2) above are not generally recommended. As regards (1), it is suggested that available information on size of units should be used at the estimation stage (see Chapter 8) rather than the sampling stage. Procedure (2) is not worthwhile in view of the relatively small differences in the variability of the main demographic parameters, and in costs, between strata, besides the general lack of information on these factors.

The third procedure is sometimes useful. For example, if a total sample of 100 000 persons is planned in a country where the urban sector accounts for 10 per cent of the population, then if a constant sampling fraction is used throughout, the urban sector will be represented by a sample of 10 000 persons. This may be too small to give reliable information on the characteristics of the urban population. If the latter is considered an important objective, the sampling fraction could be quadrupled in the urban sector and reduced by a third in the rural sector, giving an urban sample of 40 000 and a rural sample of 60 000 (total still 100 000). The unequal sampling fractions used would be allowed for in the data processing. Any such procedure is likely to reduce the precision of the national estimate. In general the best sample for the national estimate will be one selected with constant sampling fraction, whereas if one wishes to optimize the regional estimates this is done by allocating approximately equal sized samples to every region.1/ If the regions vary in size these two considerations are in conflict and a choice must be made. A reasonable approach would be to prefer the fixed sampling fraction unless there is a clear reason for wanting to improve the precision of the estimate in some sector.

Method of selection

Area units should generally be selected by systematic sampling from a list arranged geographically. Systematic sampling means selection at a fixed

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1/ It is assumed here that variance and costs are the same in all regions.

interval in the list, from a random point. This procedure automatically ensures goegraphical stratification.

When area units are too large and have to be broken down, using one of the methods described in Section 7.1, the procedure recommended for sample selection is as follows. (It is assumed that a population estimate is available for each area unit in the list.)

(1) Fix the optimum size of sample (number of persons) to be selected per area unit. (In Section 7.1 we have suggested a figure of 200-400).

(2) Compare the population figure for each area unit requiring splitting, with the optimum mentioned above. In making this comparison some allowance should be made for population growth, under- or over-enumeration, or any other factor believed to affect the current accuracy of the population figures used for the area units.

(3) This comparison will now show how many sub-units should be created in the area unit concerned. An example follows:

Assumed

Survey carried out in 1973. Sampling frame from 1970 census. Population of the area unit being considered (1970 census): 1 020

Estimated growth between 1970 and present (1973) at 2.5 per cent per year = 7.7 per cent of 1970 figure, or 7.15 per cent of 1973 figure.

Estimated under-count in 1970 census: 5 per cent of true figure.

Estimated optimum cluster size in terms of true 1973 population: 300

Computed

Total adjustment: 7.15 + 5 = 12.15 per cent of true 1973 figure. Adjusted optimum cluster size (i.e. 300 reduced by 12.15 per cent): 264. (This adjusts the 300 true 1973 figure to the equivalent 1970 census figure).

Ratio size or area unit to optimum = $\frac{1\,020}{264} = 4$ (rounded to nearest whole number)

Therefore 4 sub-units are required in this area unit.

(4) Now in the list of area units write crosses against each unit: 1 cross if the unit does not require splitting, otherwise a number of crosses equal to the number of sub-units to be created. For the area unit in the above example, enter 4 crosses.

(5) Select a systematic sample from the crosses.

Example

(a) Suppose the optimum, adjusted as above, is 250.

(b) Suppose we have decided not to split units unless their census population exceeds 1000.

(c) Suppose the sampling fraction is 1/8 and suppose we start with the random number 3 (i.e. selection starts with the 3rd cross then continues with every 8th cross thereafter.

Name of unit in census list	Census population	Sub-units	Selected (every 8th x)
NSUTA	924	x	
PEKI	1100	xxxxx	S
KOKU	398	x	
KOKOFU	1301	xxxxxx	S
DOMPA	876	x	
DANSO	212	x	
ABORI	384	x	
BONI	1026	xxxx	
TETREM	1205	xxxxxx	S

Etc.

The last column shows that 1 sub-unit is selected in each of the areas: PEKI, KOKOFU and TETREM. Note that the units under 1000 census population are not split, in accordance with decision (b) above. This is because we estimate that the additional cost of splitting is not worth the gain in sampling precision for such units (see Section 7.1). However, once we know that a unit has to be split, then splitting into 4 or 5 sub-units is virtually no more costly than splitting into 2; we therefore split into units of approximately optimal size (here 250).

(6) Sub-units now have to be created in these three areas, as many as shown by the crosses: 4 sub-units in PEKI, 5 in KOKOFU and 5 in TETREM. Note that the sub-units in BONI remain hypothetical: we do not need to create them as BONI was not selected.

(7) If method (1) is being used (area sub-units) the enumerator or supervisor divides the area into smaller areas during a field visit, using natural boundaries as far as possible and showing the sub-units on a map. Provided the boundaries are clear, it is best to make the sub-units approximately equal in current population. He numbers the sub-units and one is later selected at random.

(8) If method (2) is being used (sampling of dwellings or households) then the "sub-units" are really "sub-samples". The enumerator first lists all dwellings or households. Then a systematic sample is selected from the list by the supervisor. If 4 "sub-units" were to be created (as in PEKI), he selects a sample of 1/4; if 5 "sub-units" were to be created (as in KOKOFU or TETREN), he selects every 5th; and so on. Sampling is at a fixed interval with a random start. No sub-units are actually created.

Note A. It will be seen that if the initial sampling fraction is high, or if some areas are very large, it might happen that 2 (or more) sub-units are selected in one area. (In the example shown, this would automatically happen for any area of census population greater than 15.5 times the optimum, i.e. 15.5 x 250 = 3 875). This presents no special problem. If method (1) is being used, we simply select 2 (or more) sub-units in this area. If method (2) is used and the number of "sub-units" to be created is n, we select dwellings or households at an interval of $\frac{1}{2}$ n (or $\frac{1}{3}$ n, etc.) instead of n.

(If n is an odd number, say 7, select at intervals 3 and 4 alternatively, so as to average 3.5.)

Note B. If a mistake is made in computing the number of sub-units to be created, or in entering crosses (steps 3 or 4 above), no harm is done provided the mistaken crosses are carried through and used in steps 6, 7 and 8.

The method of sampling described above amounts to a single-stage equal probability sample of the units corresponding to crosses.

Because of the labour involved in splitting units in the field, we have suggested a cut-off of 1 000 census population: any area unit below this figure would be left as it is, without splitting. While this minimizes labour, it leads to a rather wide variation in the size of units. Some statisticians might prefer to abandon the cut-off and to split all area units into sub-units of optimal size (except, of course, those that are already near enough to the optimum not to need splitting). If nearly all units exceed the suggested cut-off, the simplest policy is probably to abandon the cut-off so that a single rule can be applied throughout. If, at the other extreme, very few units exceed the cut-off such a policy would clearly be wasteful of effort. For intermediate cases opinions may differ.

7.3. SIZE OF SAMPLE

Three factors are involved in fixing the size of the sample:

(1) The degree of sampling precision required;

(2) The degree of sampling precision expected, expressed as a function of the sample size;

(3) The available funds.

The standard formulation for solving the problem proceeds in the above order. Thus, (1) is first obtained by consulting users. Then (2) is estimated, and this leads to an estimate of the size of sample required to achieve the precision needed. The cost of this sample is then estimated and a budget is presented for approval.

In practice the process quite often happens differently. Sometimes factor (3) is the starting point: the amount of money available. In other cases the sample size is the starting point - perhaps on the basis of the experience of another country. In either of these cases it is still highly desirable to work out steps (1) and (2). This will show whether the survey as planned is likely to give useful results, and if it is not, whether the survey should be cancelled, its objectives curtailed, or the work spread over a longer period. The three factors will now be considered in more detail.

Sampling precision required

Certain aspects of this problem have been discussed in Chapter 1 and Chapter 3. The main points to be considered are the following:

(1) How much geographical detail is required in the survey results?

(2) What detailed breakdowns other than geographical are required (e.g. is fertility to be broken down by educational level, etc.)?

(3) What is the precision of existing knowledge on the topics covered by the survey?

(4) What precision is expected of the data collection process in the planned survey?

(5) What is the variation likely to be from year to year in the characteristics to be investigated?

(6) How much precision is required of the survey estimates?

Question (6) may seem at first sight to cover all that is needed. However, it is essential to ask it in conjunction with questions (1) - (5). Firstly, we need to know the precision required not merely of the overall estimates but of the breakdowns. Generally it is the latter which will determine the desirable sample size. Secondly, we need to be sure that the precision required

of the survey is substantially greater than that of existing knwoledge, otherwise the survey is not worth carrying out. Thirdly, if the error expected in the data-collection process ("response error") is as large as the maximum acceptable error, then the survey will be wasted unless some method can be found of correcting the response error. Fourthly, if the survey results are to relate to a moment in time or to a single year, then there is no point in seeking a level of error much smaller than that of the year-to-year variation.

Exact answers to all these questions cannot reasonably be expected - certainly not for all the many variables involved in a survey. However, rough answers should be attempted for all variables and precise answers to questions (1), (2) and (6) for one or two main variables such as the vital rates. For example, it might be decided that the crude birth rate is required to an accuracy of ± 2 per thousand population at 95 per cent confidence, for the north and south of the country separately. 1/

It should be mentioned here that, in practice, users are not likely to be able to give a clear answer to the question: "how much precision is required?" While users should always be consulted, it is likely to be the statistician who in the end specifies their requirements in a precise form.

As regards the precision to be expected of the data collection process (in the case of the dual record system one should include the estimation process), there are no hard data on this but rough indications come from various sources - internal consistency of the data collected in surveys, consistency with independent data, observation of field work, etc. Most experienced specialists who have worked with African demographic surveys would probably agree that it would be unrealistic to expect an accuracy in data collection better than ± 2 per thousand in the vital rates (this implies about 4 - 5 per cent of births and 8 - 10 per cent of deaths).

The position is rather similar regarding year-to-year variation in vital rates. A small amount of evidence is available from civil registration data for Sierra Leone and Tunisia and from a long-term survey in Senegal; this suggests that annual variation may generally have a standard deviation of about 3 - 4 per thousand for the crude birth rate and 2 - 3 per thousand for the crude death rate, for fairly limited regions within countries. To some extent such variations should cancel when larger areas are considered, so that for data relating to a <u>whole country</u> one might expect somewhat smaller standard deviations than the above. Further, assuming variations are random from year to year, then if the reference period is n years the standard deviation of the variation should be reduced by the factor $\sqrt{n}$.

<u>Sampling precision expected</u>

The problem of making advance estimates of sampling error is treated in Chapter 8. This is not a problem which can be solved by mathematics alone since the sampling error depends on the degree of variability and of clustering in the population concerned; these factors can only be estimated by

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1/ Ninety-five per cent confidence corresponds to twice the standard error. Hence the above would imply that the standard error of the survey estimate, for each of the two regions, should not exceed ± 1 per thousand population.

referring to results from other countries, or other studies in the same country. Mathematical methods do, however, make it possible to state how such results would be modified by changes in the sample design and size. For fuller details, refer to Chapter 8.

Available funds

In many cases these are fixed in advance. In some cases an increased budget can be allowed provided the work is spread over a period longer than one year. From a technical point of view there is often no serious objection to this - apart from the increased delay in obtaining useful results.

Relationship between size of sample, error and cost

Sampling error. If it is assumed that the type of area unit has been decided, as well as the sampling fraction f within area units (for cluster sampling f = 1), then for practical purposes the sampling error decreases as the square root of the sample size. Note that sampling error does not depend on the total population size: for a large country a given size of sample will give approximately the same sampling precision in the national estimates as a small country. It follows that a large country can use a smaller sampling fraction. In practice, however, a large country may often need a somewhat larger sample simply because a large country is likely to be divided into a larger number of regions for which data are required.

Example 1. Within a category which accounts for one-ninth of the whole sample, the relative sampling error will normally be 3 times as great as that for the whole sample.

Example 2. If we wish to reduce sampling error by 50 per cent we must quadruple the sample size.

Example 3. Country A has 5 million population, country B has 10 million. A sample of 100 000 is selected in each country. The estimated national birth rate will have approximately the same sampling error in each country. However, if both countries are divided into provinces of 1 million population, and the sample is spread evenly throughout the country, then country A will get a sample of 20 000 in each province, while country B will get a sample of 10 000 in each province. The sampling error for the birth rate in a given province will therefore be approximately $\sqrt{2}$ times as great in country B than in country A (i.e. 40 per cent greater error for country B).

Response error. This will not depend on the size of the sub-group of the sample considered. 1/ Nevertheless, taking the survey as a whole, a larger total sample is likely to mean larger response errors all round, simply because a large operation is more difficult to control efficiently than a small one.

1/ In practice, however, there are many reasons why the rate of error will vary in particular sub-groups. For example, error in reporting age will be greater among older people, among the less educated, and among the rural population.

Year-to-year variation. Relative variation can be expected to be greater in small regions, and smaller when averaged over the whole country. Considered as error, its incidence is reduced if the sample is reduced in numbers and extended in time (for example, half as many sampling areas for 2 years instead of 1 year). Note, however, that modern analysts of demographic survey data generally prefer to prepare estimates based on cross-checking and mutual adjustment of several sources of data and where this is done the time reference cannot normally be regarded as a single year. The problem of year-to-year variation becomes serious only where estimates are taken direct from the single question on events in the last 12 months.

Cost. Again assuming a given type of area unit and a given sampling fraction within area units, field costs are directly proportional to sample size. Total cost, however, is likely to include some overheads which do not increase with sample size.

Note the contrasting behaviour of sampling error and response error. As we consider smaller and smaller sub-groups of the sample, the sampling error increases but the response error remains constant. Thus there will come a point at which sampling error exceeds response error. It is essentially this point which determines the desirable size of the sample. The reasoning may be set out in three steps thus:

(1) There is no purpose in reducing sampling error to a level much below that of response error.

(2) Thus, in the smallest sub-group for which we wish to report results the sample size should be such that sampling error is comparable to response error (perhaps somewhat smaller than response error, but not much smaller).

(3) If this size is known, then the size of the whole sample follows.

In practice the sample size is not always selected by such reasoning because, as we have noted, the cost or the total sample size may often be imposed as the starting point. In this case, the argument should be followed in the opposite direction to determine what is the smallest sub-group for which we may reasonably report results: as long as sampling error is below response error, results can certainly be reported (or else the survey should not be attempted at all), but when sampling error begins to draw level with response error one has to consider whether total error is acceptable. 1/ Of course, the size of the response error can only be guessed (if it were known we could remove it); for this purpose we have to rely on past experience and other surveys.

A similar situation exists when the sample size is determined by the needed precision on one particular variable which is considered to be of overriding importance. (For example, we may need a standard error of ± 1 per

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1/ Response error or bias b is usually added to sampling error σ on a "root mean square" basis; i.e. total error = $\sqrt{b^2 + \sigma^2}$.

thousand population in the birth rate for the whole country.) For the other variables the position is then the same as if the sample size were imposed; that is to say, we once again attempt to work out what would be the most detailed breakdowns which would give an acceptable error.

It is sometimes argued that "response error is much more important than sampling error in surveys". If this means that response error is much greater than sampling error, it may be true for some of the total estimates but it ought not to be true of the sub-groups. If it is, then the sample is unnecessarily large. If the assertion that response error is more important means that the statistician should give more attention to problems of response error than sampling error, this is sound advice. Sampling error has to be considered at the planning stage and in evaluating the results; on the whole the problems it presents are straightforward and well understood. Response error has to be considered at all stages of the work. Its causes are various and ill understood and its effects are difficult to predict. Only one thing is certain: its reduction depends above all on continuous and painstaking supervision of field work.

Subsampling for different characteristics

It may easily happen that the desired sample size, worked out in the way suggested above, will be different for different variables in the demographic survey. This suggests the possibility of using two or more questionnaires. The items requiring the largest sample would be included in one questionnaire which would be used for the whole sample; other items would be put in one or more separate questionnaires which would be used for subsamples only.

In practice the advantages of this procedure are doubtful. We have already mentioned that the proportion of the enumerator's time spent in asking a particular question and recording the answer is likely to be small. The method therefore has limited value for saving field costs. As for saving in data processing, the same saving can be achieved by introducing sub-sampling at the processing stage, after collecting data from the full sample. The only marked advantage of the method lies in the possibility of simplifying enumerators' training and instructions by limiting the supplementary questionnaire to a subsample of enumerators; these can be selected as the most competent and given special training. However, if the subsample is to be limited to certain enumerators, it must be an area subsample. We have seen in Section 7.1 that this is an inefficient method of sampling for characteristics which are highly clustered; the latter include economic characteristics, education, religion, ethnic group and housing characteristics. Thus the scope for subsampling for special topics is fairly limited.

An application worth considering is the use of a detailed pregnancy history questionnaire in a subsample of areas. Such a questionnaire covers a period of fertility experience averaging several years for each adult woman questioned; valuable results can therefore be obtained from a much smaller sample of women than when questions are limited to the last 12 months. This approach has already been discussed in Chapter 5.

Finally, in the absence of a census, there is sometimes a requirement for a large sample designed to give a detailed geographical breakdown of total population, with all other variables limited to a smaller sample. This implies two operations, which may be termed the enumeration and the survey. If no vital rate follow-up is planned, a good plan would often be to apply method (2) of Section 7.1 (subsampling dwellings or households within area units). The listing of dwellings or households would provide the enumeration, and a second visit would then be made to a subsample for the survey. In some cases this method will not give the required sample sizes; in other cases a follow-up survey is planned and then the advantage of cluster sampling is overwhelming (see Section 7.2); for either of these two situations area subsampling will be the most suitable method - that is, the enumeration would be carried out in all the sample areas and the survey in a subsample of these areas. For a multi-round survey, a modification of this plan would be to carry out the first round on the full sample of areas but to limit the follow-up rounds to a subsample of areas. This design might be appropriate where it was planned to continue the follow-up survey over a longer period; a small sample might then be compensated by the long time coverage.

Sample size in typical African surveys

Strictly speaking, the size of sample used in past surveys has no direct bearing on the size that is desirable. In practice, however, governments planning surveys are inevitably influenced by what has been done before or elsewhere. It is therefore perhaps useful to report here that, if one excludes surveys directly linked to a census, most African demographic surveys have been based on samples of between 100 000 and 200 000 persons.

The problem of sample size is discussed again in the next chapter (Section 8.3), where we indicate the orders of magnitude of the sampling errors to be expected both in the crude and in the age-specific vital rates, given various sizes of random sample. It is concluded that these typical sample sizes of 100 000 - 200 000 persons can be expected to yield results of reasonable accuracy, given the expected size of the non-sampling errors and the analytical techniques which should be used when interpreting the data. However, samples of this size cannot be expected to yield precise information on sex-age specific mortality by five-year age groups, or on annual changes in the vital rates (if the survey is continued for more than one year), or on the seasonal variations in fertility and mortality.

It is recommended, therefore that the figure of 100 000 persons, or 20 000 households, should be regarded as the minimum acceptable sample size, and if the clusters are large (averaging about 1 000 persons or more), the sample size should be increased accordingly.

7.4 SAMPLE DESIGN FOR SPECIAL OPERATIONS

The post-enumeration surveys (PES)

As the PES is intended to check coverage, the sampling unit should be complete census enumeration areas and the selected units should be exhaustively covered in the survey. This implies an area cluster sample of EAs. This

is a similar sample design to that recommended in Section 7.2 (except that large area units should not now be sub-divided) and once again the selection of area units should be systematic and with equal probability. A sampling fraction from 1/10 to 1/20 is typical.

An interesting modification of this plan was used in the 1966 Population Census of Malawi. It was noted that three kinds of coverage error required checking: missing of villages within EAs, missing of dwellings within villages, and missing of persons within dwellings. Each of these requires a more intensive type of check than the one before. Resources can therefore be economized if the three checks are performed on progressively smaller samples. A sample of 1/40 EAs was selected for the check on omission of villages. Within the selected EAs, 1/3 villages were selected for the check on missed dwellings, and within the selected villages 1/2 of the dwellings were visited for the check on missed persons.

It is important not to omit any of these checks. In some PES's the check has been confined to a sample of dwellings or households selected from the census results. This does not check the census coverage of villages, dwellings or households.

The built-in sample (BIS)

We have already indicated in Chapter 2 that in African conditions the BIS should be based on a cluster sample of enumeration areas. Again these should be selected by systematic sampling with equal probability, and again a sampling fraction from 1/10 to 1/20 is typical. Although these areas are likely to be larger than the optimum for efficient sampling discussed earlier, the advantages of basing the sampling on the unit of enumeration are overwhelming since it allows each enumerator to be trained either for the short form or for the long form but not for both together.

In the Kenya, Uganda and Zambia censuses of 1969 the sampling unit was a small group of EAs, usually a census "supervisor's area". In these censuses the EAs were created only at the time of the main census operation itself and it was felt that the risk of biased sampling would be too great if it were left to the supervisor to select the sample in the field at the last moment while allocating the work to the enumerators. Thus the sample was selected in terms of larger units corresponding approximately to supervisors' areas. It was recognized that this decision implied a larger sampling error but in view of the very large total sample this was considered acceptable.

Dual record method (PGE)

The arguments advanced in Section 7.2 for cluster sampling of small area units apply also to this type of operation.

In some countries an attempt has been made to use the official civil registration system to provide the registration side of the combined operation. However, the registration areas in the official system are generally much too

large; the choice is then between a highly inefficient sample based on excessively large areas, or limiting the survey part of the operation to a sub-sample within each registration area. The latter leads to serious problems in matching the survey results against the registration results. There is no doubt that the combined operation works better if the registration is set up specially as part of the project.

In dual record systems the question of optimum cluster size raises a number of special issues. The problem seems best deferred to Chapter 11, where the dual record technique is treated in detail.

7.5 SUMMARY

1. Samples for demographic surveys in Africa should in general be area cluster samples, that is, there should be complete coverage of the population within the selected area units.

2. Area units should ideally be of size 200 - 400 persons. 1/ They should be selected with equal probability by systematic sampling from a list arranged in geographical order.

3. More often than not, explicit stratification will be unnecessary. Its most common application may be to allow the use of differing sampling fractions in order to ensure an adequate sample size in areas of special interest (such as the urban sector, or an exceptionally small administrative region).

4. Area units over 1 000 population (an arbitrary, but recommended, cut-off) should be considered excessively large for efficient sampling. There are three ways of dealing with them:

   (1) After selection of the area sample, excessively large units may be split into smaller units of optimum size, one of which is then selected at random.

   (2) In the excessively large units selected in the sample, dwellings or households may be listed and a sample then selected systematically, at a sampling interval designed to give the optimum of 200 - 400 persons.

   (3) The large units may be retained despite the loss of efficiency involved.

In methods (1) and (2), the subdividing of large units is carried out on paper only before sampling. It is then carried out in reality (i.e. in the field) for those area units selected in the sample (See Section 7.2 for details).

5. Areas under about 100 population are excessively small and should be grouped with others before sampling - with neighbours if possible, or with nearby areas if exact location is uncertain.

1/ In the case of dual record systems, this question is discussed more fully in Chapter 11.

6. Area units used for sampling should have clearly defined boundaries. This requirement is much more important if the survey aims to estimate totals, as opposed to rates, proportions or averages.

7. Total sample size is decided, basically, by bringing expected sampling error into line with required sampling error. The former diminishes as the square root of the cost.

8. Required sampling precision must be considered in relation to: the amount of detailed breakdown required into geographical or other sub-groups; the precision of existing knowledge; the expected level of response error; and the expected year-to-year variation of the survey variables.

9. Demographic surveys in Africa (other than the PES and BIS mentioned in 10 below) have generally employed samples of from 100 000 to 200 000 persons. The former figure should be regarded as the minimum acceptable sample size.

10. Census samples, whether "built-in" or "post-enumeration", should be cluster samples of census enumeration areas, typically 5 -10 per cent selected systematically. (A more sophisticated PES sample is described in Section 7.4.)

References

Cochran, W.G. (1963), Sampling Techniques, New York and London, Wiley.

Som, R.K. (1973), A Manual of Sampling Techniques, London, Heinemann.

U.S. Bureau of the Census (1968), Sampling Lectures, ISP Supplemental Course Series, No. 1.

Desabie, J. (1966), Théorie et pratique des sondages, Paris, Dunod, Vol. X.

Yates, F. (1951), Méthodes de sondage pour recensements et enquêtes, Paris, Dunod.

CHAPTER 8

ESTIMATION AND SAMPLING ERROR

8.1 DEFINITIONS, ASSUMPTIONS, AIMS

General note

Estimation and sampling error are fully discussed in many textbooks which are readily available. In this chapter, therefore, we give only an elementary discussion, covering the main points which are relevant to African demographic surveys.

In sampling theory, the population from which the sample is selected is generally called the universe. The purpose of a sample operation (or survey) is to use the sample to draw conclusions about the universe. This process of stepping from the sample to the universe is called estimation (sometimes "raising" or "inflation"). Generally a mathematical formula can be given for the estimation process. For example, if we have drawn the sample by selecting one unit in 10, one formula for estimating the universe total would be: "10 times the sample total". There are, however, any number of estimation formulae that can be used; some are better than others, in ways which will be discussed later. The formula chosen must of course take account of how the sample was selected; but once we have taken account of this there is still some choice left between different formulae and often the choice is not easy.

Any estimate from a sample will be subject to sampling error. The exact meaning of this will be defined later but meanwhile it is obvious that the sample cannot expect to represent the universe perfectly, so that we must expect sampling error.

Quantities to be estimated

In demographic surveys we are interested in estimating four main types of quantity: totals, means, ratios and proportions. This requires some further explanation.

Totals. For example: the total number of persons in the country; the total number of children under 5 in the Western Province.

Means. A mean is simply a total divided by the number of observations going to make up the total. This latter number can be regarded as constant.

Ratios. For sampling purposes we speak of estimating a ratio only if both the numerator and the denominator are subject to sampling error.

Ex. 1
Suppose we estimate the rate of increase of the population by dividing the population found in the survey sample by the population reported in the same sample of areas in the course of the census carried out a year earlier, thus:

$$\text{Rate of increase} = \frac{\text{Survey pop. in sample areas}}{\text{Census pop. in sample areas}} \times 100$$

Here both numerator and denominator are subject to sampling error;

Ex. 2

Alternatively we could have used the following estimate:

$$\text{Rate of increase} = \frac{\text{Survey pop. estimate, whole country}}{\text{Census population for whole country}} \times 100$$

Here the denominator is fixed and not subject to sampling error. If the denominator is N', then this estimate behaves like an estimate of a total (the numerator) multiplied by the constant 100/N'.

Proportions. Example: the proportion of persons aged 20 - 29; the proportion of persons who are male.

Proportions are like means but relate to the case where the variable is a yes-or-no characteristic. If we score 1 for yes and 0 for no, the numerator is simply the total score. Thus a proportion is a special case of a mean in which the variable can take only the values 1 or 0.

Percentages. These are simply proportions multiplied by 100.

Vital rates are very nearly proportions (multiplied by 1000) and can be treated as such without serious error. Thus the birth rate is nearly the proportion of persons in the whole population who gave live birth in the year concerned (not quite, because a few women give birth to more than one child in a year). The death rate is nearly the proportion of persons who died during the year among those who were living at the beginning of the year (not quite because some died who were not yet living at the beginning of the year).

In sampling, proportions are easier to deal with than ratios and it is reasonable to regard vital rates as proportions at least for purposes of advance estimation of sampling error.

Thus all quantities to be estimated in demographic surveys can be regarded as totals, ratios or proportions (or these multiplied by a constant). Later in this chapter we shall give formulae for estimation and sampling error for each of these three.

Sampling error

Probability sampling is any method of sampling which gives a definite non-zero probability of selection to every unit in the universe. 1/ Sampling

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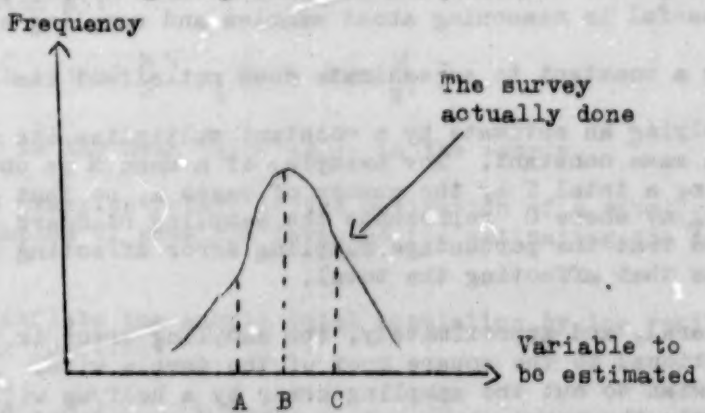
1/ Two well known sampling methods which cannot be classified as probability sampling are quota sampling and purposive sampling.

theory is based on the assumption that probability sampling is used, and this assumption will be made in the rest of this chapter. In any probability sampling method there will be one or more steps of the sampling procedure which involve a random choice. The set of all possible choices at this point (or these points) corresponds to the set of all possible samples for this particular sample design.

We shall assume now that one particular estimation formula has been chosen. In general, the different possible samples would give somewhat different survey results and hence different estimates. The set of estimates made from the set of possible samples will spread over a range of values. The wider their spread the greater the sampling standard error (or random sampling error) of the estimate. The sampling standard error of an estimate is defined as the standard deviation of the distribution of the estimates that would be obtained from the set of all possible samples. 1/ More simply, it is the standard deviation of the "uncertainty due to sampling".

Note, however, that the mean of the set of all possible sample estimates is not necessarily the true universe value. In the first place the sampling or estimation method might be biased: the mean of all possible sample estimates might not equal the universe mean, although generally we try to use a sample design which is not biased in this sense. And secondly, even the universe mean may not be the truth because there may be non-sampling errors - e.g. reporting errors. The difference between the mean estimate of all possible samples and the truth is called the bias, which is made up of sampling bias and non-sampling bias.

In certain circumstances, sampling theory enables us to estimate the sampling error - that is, random sampling error and sampling bias if any. Random sampling error thus estimated reflects the variability among different possible samples. As such, it can be used as a measure of the uncertainty due to sampling. It does not tell us how much actual error attaches to the estimate from any particular sample (such as the sample we selected), but it does enable us to state the probability that the random error in a given sample will exceed a given size for a sample selected according to a given procedure. The following diagram may clarify this.



1/ Strictly, we should add here: "each weighted by its probability of selection". We will take this additional refinement for granted in the rest of this section.

The curve represents the results of an infinite number of imaginary surveys. The height of the curve shows the relative frequency with which each possible result would have occurred.

A = the true, universe value
B = the mean of all possible samples (the mean of the curve)
C = the particular result obtained from the one survey that was actually carried out (we have arbitrarily chosen to place this to the right of B).

The interval A to B is the bias.

The interval B to C is a random variable, varying from one possible survey to another with mean zero and standard deviation equal to the sampling standard error.

In surveys, the use of sampling theory to estimate sampling error has two quite distinct applications:

(1) In advance of the survey we want to estimate the expected sampling error in order to decide on a suitable sample size and an efficient sample design.

(2) After the survey we want to estimate the sampling error in order to show what degree of confidence can be placed in the results.

The survey results themselves normally provide the best estimate of sampling error and are therefore used for purpose (2) above, but of course they are not available for purpose (1). For (1) we use a combination of sampling theory and past experience of similar surveys, and we aim to find formulae linking expected sampling error with those features of the sample design over which the sample designer has some choice - such as size of sample, cluster size, stratification. This will help him to optimize his choice in terms of sampling error. These two purposes lead to very distinct approaches in practice and we treat them separately, in Sections 8.3 and 8.4. But before doing so we examine in Section 8.2 the problem of choosing an estimation formula.

Before closing this introduction we mention three simple principles which are constantly useful in reasoning about samples and sampling error.

(I) Adding a constant to an estimate does not affect its sampling error.

(II) Multiplying an estimate by a constant multiplies its sampling error by the same constant. For example, if a mean M is obtained by dividing a total T by the number of cases n, so that $M = T/n$, then $O_M = O_T/n$, where O represents the sampling standard error. It follows that the percentage sampling error affecting the mean is the same as that affecting the total.

(III) In general, and approximately, the sampling error is inversely proportional to the square root of the sample size. For example, if we wish to cut the sampling error by a half we will have to quadruple the sample size. In a multi-stage sample this only applies at the first stage (cluster sizes and strata are assumed to stay the same). The rule also assumes that the sampling fraction is not too large. It will be seen from this that the sampling error depends on the size of the sample, not on the sampling fraction.

8.2 CHOICE OF AN ESTIMATION FORMULA

Suppose m clusters are selected by simple random sampling from a total of M clusters in the country. Suppose that in the i-th sample cluster we find y_i events (births, deaths, or whatever) in the last 12 months and n_i inhabitants, and suppose that the population census, up-dated by the best available extrapolation, gives n_i' inhabitants for this cluster. There are now at least four plausible methods of estimating the vital rate R per thousand population.

In the formulae which follow we indicate an estimate by placing the sign ^ over the symbol for the quantity to be estimated. Four possible estimates are the following:

(i) We could average the vital rates found in the m clusters:

$$\hat{R} = \frac{1}{m} \sum_i \frac{1000 y_i}{n_i} \qquad \text{---(1)}$$

(ii) We could estimate that the vital rate in the whole country will equal the rate found in the sample:

$$\hat{R} = 1000 \, \Sigma \, y_i \Big/ \Sigma n_i \qquad \text{---(2)}$$

(iii) We could proceed as in (ii) but using the up-dated census populations n_i' for the denominator:

$$\hat{R} = 1000 \, \Sigma \, y_i \Big/ \Sigma \, n_i' \qquad \text{---(3)}$$

(iv) We could estimate total events in the country using the survey, then work out the rate on the basis of the up-dated census country-total population N':

$$\hat{R} = 1000 \, \frac{M}{m} \Sigma \, y_i \Big/ N' = 1000 \, \frac{M}{N'} \, \bar{y} \qquad \text{---(4)}$$

where $\bar{y}$ is the mean value of y_i in the sample.

The above examples relate to the estimation of a vital rate. Here are three more examples of possible formulae for estimating the total population, N.

(v) We can inflate the sample total population by the reciprocal of the sampling fraction:

$$\hat{N} = \frac{M}{m} \Sigma \, n_i = M \bar{n} \qquad \text{---(5)}$$

(vi) Instead of inflating by M/m (i.e. the ratio of total clusters to sample clusters) we can inflate by the ratio of total population to sample population, using the up-dated census figures:

$$\hat{N} = \frac{N'}{\sum n_i'} \sum n_i \qquad \text{—(6)}$$

Another way of looking at this formula is to say that we adjust the up-dated census total N' by a correction factor based on the survey, namely the ratio of survey to up-dated census found in the survey clusters:

$$\hat{N} = N' \left[\sum n_i \Big/ \sum n_i' \right] \qquad \text{—(6')}$$

This is identical with formula (6).

(vii) We can make the same kind of adjustment, but using the <u>difference</u> rather than the <u>ratio</u> for adjustment. Thus, within the sample we obtain the difference: survey population minus up-dated census. We inflate this to the national level by multiplying by the raising factor M/m. Finally we add this correction to the up-dated census total:

$$\hat{N} = N' + \frac{M}{m} (\sum n_i - \sum n_i') = N' + M (\bar{n} - \bar{n}') \qquad \text{—(7)}$$

This may be rewritten in the form:

$$\hat{N} - N' = M (\bar{n} - \bar{n}') \qquad \text{—(7')}$$

From this we see that this method of estimation amounts to assuming that the difference "survey minus census" in the universe can be obtained by multiplying the same difference in the sample by the usual raising factor.

There is thus a considerable choice of plausible estimation formulae, whether we are estimating rates or totals. (The above list is certainly not exhaustive 1/). How is the most suitable formula to be chosen? There are no firm rules for this: several considerations must be taken into account, of which perhaps the most important is the question of sampling error. We shall now illustrate the kind of reasoning that is appropriate.

Firstly, method (ii) - which estimates the rate for the country as equal to the rate found in the sample - is certainly preferable to (i) - the straig average of the rates in the m sample clusters. It is widely accepted that th

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1/ In particupar, ratio estimates - method (vi) - are used in a wide variety of forms often with quite different variables in numerator and denominator. For example, the number of employed persons found in a survey may be raised by the ratio: census adult males in the population to census adult males in the survey clusters.

appropriate way to average ratios is to sum the data going into the numerator and sum the data going into the denominators and divide the former by the latter. This procedure gives equal weight to equal units: in the case of birth rates, for example, it gives equal weight to every person, whereas a straight average of the cluster rates would give equal weight to every cluster. Clusters vary in size and it seems obvious that we want to give more weight to a large cluster. This is essentially a question of the appropriate definition for an average rate.

Comparing (ii) with (iii), the only difference is that (iii) uses the census instead of the survey in the denominator of the rate. Two issues arise. Firstly, is n (the survey) more accurate than n' (the up-dated census)? In African countries censuses are often more accurate than surveys because the publicity which accompanies censuses ensures full reporting. On the other hand the up-dating is a source of error. This question has to be judged on its merits in each case, on the basis of local knowledge of the particular census and the particular survey. Secondly, (ii) has a marked advantage over (iii) because in (ii) the data for the numerator and the denominator come from the same operation (the survey): this means that any error of coverage (failure to contact certain households, error in identifying the area, etc.) affects both numerator and denominator together and so tends to cancel out. This advantage would generally, in Africa at least, over-ride th first consideration, so that, overall, we would normally do better to use the survey as the base for the rates, rather than the census, i.e. (ii) should be preferable to (iii). 1/

Turning to estimate (iv), here the survey numerator is first raised to the national level before dividing by the census denominator. Note first tha in any survey the clusters are certain to vary considerably in population siz Thus there is a definite chance that one might select a sample of exceptional ly large or exceptionally small clusters. In estimate (iv), choice of a sample of exceptionally populous clusters would lead to an excessively large num ber of births, with a consequent over-estimation of the birth-rate. In estimates (ii) and (iii) the population of the sample clusters appears in the denominator so that this source of error cancels out. This error is just one kind of sampling error and is duly reflected in the formulae for the standard error of the estimates: it will be found that estimates (ii) and (iii) usuall give a substantially smaller sampling error than (iv).

Thus, among the first four estimation formulae, (ii) is in most cases th best to use in an African demographic survey. In other words, we take the rates found in the sample as representing the universe.

1/ In dual record systems this argument applies less strongly because th numerator comes from a dual source, unlike the denominator. If the system us area units based strictly on census enumeration areas and if these are well mapped and identifiable there may then be a case for estimate (iii), though these conditions are likely to be rare in Africa. (See Section 11.2). In estimation for a "built-in sample" operation constituting part of a census (see Chapter 2), n and n' are identical for sample clusters, so that methods (ii) and (iii) are the same.

Comparing estimation formulae for totals, in (v) the raising factor is the ratio total number of clusters to number of clusters in the sample, while in (vi) it is the ratio total population to population in the sample. It is easy to understand that (vi) is preferable to (v), if only because the ratio of universe to sample is more accurately measured by the raising factor $N'/\sum n_i'$ than M/m. Alternatively we can use the same argument as above: if we happen to choose a sample of unusually large clusters, in (v) this will lead to an overestimate, while in (vi) the factor $\sum n_i'$ in the denominator will cancel this error.

Before considering method (vii) let us return to the concept of a ratio estimate, mentioned earlier. Essentially, this is an estimate which consists of the ratio of two quantities, each subject to sampling error, multiplied by a constant. Thus, formulae (2), (3) and (6) are ratio estimates because each contains $\sum n_i$ or $\sum n_i'$ in the denominator, a quantity whose value depends on the sample selected. We have seen that it is just the presence of this factor in the denominator that helps to reduce sampling error, and this argument is true more generally: ratio estimation will always reduce sampling error if there is a large enough positive correlation between the variables in numerator and denominator. In particular, in using census data to inflate the survey estimate of total population, or of any other total measured in both the survey and the census, the correlation should normally be high enough to ensure a large increase in sampling efficiency from ratio estimation.

There are, however, two disadvantages of ratio estimation:

(1) The ratio estimate involves an approximation which assumes, among other things, a large sample. For small samples it is biased, and the bias cannot be removed without greatly increasing the sampling error. Generally this bias is small and is ignored, but if the number of sample clusters is small (say under 20) and if several such ratio estimates are added together for a number of strata, then the bias may become substantial compared with the sampling error. This sometimes happens in a census built-in sample but in other cases it is rare.

(2) If ratio estimates are computed for special categories they will not generally add up consistently. For example, if formula (6) is computed first for males (with N', n_i' and n_i all restricted to males), to give the male population N_m and then for females to give the female population N_f, it will be found that $N_m + N_f$ is not equal to the overall ratio estimate N given by formula (6). This leads to some irritating problems in preparing the tabulation programme, though they can be easily overcome if foreseen at the programming stage.

Neither of these difficulties is likely to be over-riding and in most cases ratio estimates are to be preferred where available.

Method (vii) is called the "difference estimate". This amounts to assuming that the difference "survey minus census" for the average survey cluster is representative of all clusters. It does not suffer from the disadvantages

(1) and (2) above but in many practical applications will not give as small a sampling error as the ratio estimate (vi).

Finally we note that this section began with the assumption of a cluster sample in which all clusters were selected with equal probability. We now consider three common departures from this assumption.

(a) Stratification

To estimate a total, the simplest procedure is to apply one of the above estimates within each stratum, then to add together the stratum estimates thus obtained.

For a rate, one can apply one of the above estimates within each stratum to obtain R_1, R_2, etc., then compute a weighted mean using the census populations N'_1, N'_2 etc. of the strata as weights, thus:

$$\hat{R} = \frac{N'_1 \hat{R}_1 + N'_2 \hat{R}_2 + \ldots}{N'_1 + N'_2 + \ldots} \qquad \text{—(8)}$$

In such a weighted mean any errors in the weights normally have very little effect.

An alternative, and perhaps commoner, estimate with stratification is the "combined ratio estimate", in which R is computed for several strata together. Thus, a rate $R = ky/x$ would be estimated by estimating Y and $\hat{X}$ separately and computing $\hat{R} = k\hat{Y}/\hat{X}$. More exactly,

$$\hat{R} = k \frac{\hat{Y}_1 + \hat{Y}_2 + \ldots}{\hat{X}_1 + \hat{X}_2 + \ldots} \qquad \text{—(9)}$$

where $\hat{Y}_h$ and $\hat{X}_h$ are the estimated totals of y and x in stratum h. Such an $\hat{R}$ might be computed for the whole survey universe or for a limited domain covering several strata.

(b) Cluster sampling with varying probabilities

Up to now, each cluster has been assumed selected with the same probability, equal to m/M. In some sample designs the clusters are selected with varying probabilities. If the i-th cluster is selected with probability p_i, then, to remove the resulting bias, the data for that cluster must be weighted by $1/p_i$ in the estimation formula. Thus, in all the estimation formulae quoted, y_i should be replaced by $(y_i/p_i) \times (m/M)$, and similarly each n_i by $(n_i/p_i) \times (m/M)$ and each n'_i by $(n'_i/p_i) \times (m/M)$. For example, formula (2) becomes:

$$\hat{R} = 1000 \left[\sum \frac{y_i}{p_i} \right] \Big/ \left[\sum \frac{n_i}{p_i} \right]$$

while formula (4) becomes:

$$\hat{R} = \frac{1000}{N'} \sum \frac{i}{p_i}$$

In practice this sample design is likely to be used for one specific purpose: to introduce selection probabilities proportional to size - meaning population size in the case of demographic surveys. The p_i which appear in the estimation formula then give a factor in the denominator proportional to population. This gives a similar advantage to that provided by the ratio estimate. Thus, the supplementary information from the census can be used either in the sample design or in the estimation, to reduce the sampling error.

(c) Multi-stage sampling

As long as the sampling fractions remain constant within any given stage the modifications this introduces into the estimation formulae are obvious. For two-stage sampling, if m is still the number of first-stage units selecte and if the second-stage sampling fraction is f_2, then each y_i and n_i must now be inflated by the factor $1/f_2$ in the formulae quoted.

8.3 ADVANCE ESTIMATION OF SAMPLING ERROR

A. Random sample: formulae

It was pointed out in Chapter 7, Section 7.3, that an advance estimate o the sampling error, expressed as a function of the sample size, is one of a number of elements which are needed in order to reach a rational decision abo sample size. In this section we show how such advance estimates can be made.

A useful approach for advance estimation of sampling error for rates, proportions and percentages is to begin by assuming a strictly random sample. For such a sample, sampling theory gives us mathematical formulae for estimat ing sampling error, assuming only that we can make some advance estimate of t rate, proportion or percentage itself. Once we have these results for a rand sample, we can estimate the effect of modifications in the sample design; thi is discussed in Section C below.

For a proportion p and a random sample of size n, the estimate of p is subject to a sampling standard error of approximately 1/

$$\sigma_p = \sqrt{\frac{p(1-p)}{n}} \qquad \text{---(10)}$$

1/ Advance estimation of sampling error is a very approximate process. Small corrections (such as the finite population correction) can reasonably be ignored.

For a <u>percentage</u> P = 100p it is easily shown from the above that

$$\sigma_P = \sqrt{\frac{P(100-P)}{n}} \qquad \text{—(11)}$$

For a <u>vital rate</u>, R per thousand, we have already noted that this is nearly equivalent to a proportion multiplied by 1000, or R = 1000p. This gives

$$\sigma_R = \sqrt{\frac{R(1000-R)}{n}} \qquad \text{—(12)}$$

here n is the number of persons in the sample. For advance estimation we need only very rough results and in many cases the terms 1000-R may be taken as approximately equal to 1000, giving 1/

$$\sigma_R = \sqrt{\frac{1000R}{n}} \qquad \text{—(12')}$$

Some rates are expressed in relation to a sub-group in the sample. For example, the infant mortality rate is expressed "per thousand live births". In this case formula (12) still applies with n as the number of live births, but of course the latter is not known in advance so will have to be estimate using the advance estimate of the birth rate. Similarly, formula (12) may be used for an age-specific death rate, with n as the number of persons expected in the sample in the age-group concerned.

The <u>sex ratio</u> or <u>masculinity ratio</u> at birth r_o is defined as the number of male live births per 100 female live births. If p is the proportion of males among all live births, then it is easily seen that

$$r_o \doteq 100\ (4p - 1)$$

(The approximation ignores second and higher powers of the difference p - 0.5

Hence

$$\sigma_{r_o} \doteq 400\ \sigma_p = 400\sqrt{\frac{p(1-p)}{n}}$$

where n is the number of live births in the sample. Putting p = 0.5 we can base an advance estimate on the formula

$$\sigma_{r_o} = \frac{200}{\sqrt{n}} \qquad \text{—(13)}$$

where n is the advance estimate of the number of births in the sample. For example, with a sample of 100 000 persons and a predicted crude birth rate of 50 per thousand, we expect 5 000 births and the standard error of the sex rat will be approximately $200/\sqrt{5000} = \pm 2.8$.

1/ This approximation amounts to assuming a Poisson distribution instead of a binomial distribution.

All these formulae require advance estimates of the actual rates, percentages or proportions which the survey is going to measure. In practice, however, these estimates can be very rough and this requirement generally presents no problem.

However, no comparable formulae can be given for advance estimation of sampling errors of totals or means. For these, the sampling error depends on the variance in the population. For simple random sampling, the standard error of an estimate $\bar{x}$ of a mean is

$$\sigma_{\bar{x}} = \sqrt{\frac{V}{n}} \qquad \text{—(14)}$$

where V is the population variance of the variable whose mean we wish to estimate and n is the sample size. Totals are estimated in many cases by multiplying the sample total by N/n, where N is the total population - which is the same as multiplying the estimated mean by N. Thus $T = N\bar{x}$. In this case the estimate T has standard error

$$\sigma_T = N\sqrt{\frac{V}{n}} \qquad \text{—(15)}$$

Formulae (14) and (15), to be useful, require an advance estimate of V, the population variance. This is often more difficult to obtain than an advance estimate of a rate or percentage, which is all that we need in order to apply formulae (10) to (13). In any case, in demographic surveys the crucial variables are generally rates, so that formula (12) is the most useful of those quoted above. It is worth while, therefore, examining its application to some of the rates most commonly used in demographic analysis.

B. Random sample: application to some commonly used rates

Table 1 shows the results of applying formula (12) for a population with a birth rate of 45 per thousand and a death rate of 20 per thousand. The table shows 95 per cent confidence limits, which correspond to twice the standard error; these are expressed first as deviations in the actual rates per thousand (2σ) and secondly as percentages of the rates ($200\sigma/R$). Confidence limits are also shown for the rate of natural increase, based on the assumption that birth and death rates are not correlated. 1/

1/ The standard error of the rate of natural increase has thus been computed as $\sqrt{\sigma_b^2 + \sigma_d^2}$, where σ_b and σ_d are the standard errors of the crude birth and death rates. In some developing countries small positive correlations have been reported between the birth and death rates, which would mean a reduction in the standard error of the rate of natural increase; but it seems unwise to rely on this at the survey planning stage. The "95 per cent confidence limit" may be taken as approximately twice the standard error; there is a 95 per cent probability of any given survey producing a result within these limits of the true universe value, assuming zero bias.

Table 1. Ninety-five per cent confidence limits for crude birth and death rates and rate of natural increase assuming a random sample

Sample size (assumed random)	Birth rate (45 °/oo)		Death rate (20 °/oo)		Rate of natural increase (25 °/oo)	
	2σ a/	200 σ/R b/	2σ a/	200 σ/R b/	2σ a/	200 σ/R b/
25 000	± 2.6	± 5.8 %	± 1.8	± 8.9 %	± 3.2	± 12.7 %
50 000	± 1.9	± 4.1 %	± 1.3	± 6.3 %	± 2.2	± 8.9 %
75 000	± 1.5	± 3.4 %	± 1.0	± 5.1 %	± 1.8	± 7.3 %
100 000	± 1.3	± 2.9 %	± 0.9	± 4.4 %	± 1.6	± 6.3 %

a/ Expressed in per mill points.

b/ Expressed as percentage of the assumed rate R.

Crude birth rates and death rates do not, however, constitute a satisfactory basis for the construction of population projections or for various other uses of demographic statistics in social and economic development planning. Some vital-rate surveys aim, therefore, to obtain information on age-specific mortality, from which abridged life-tables can be constructed. For this purpose, however, substantially larger sample sizes are required, the formula for the standard error becoming:

$$\sqrt{\frac{1\,000\,R\left(1-\frac{R}{1\,000}\right)}{k\,n}} \qquad \text{---(12a)}$$

where k = the proportion of the total sample population (n) which is in the age group for which the mortality rate (R) is required. On the same assumption of the random distribution of the surveyed events, Table 2 shows the relationship between sample size and the confidence intervals of estimates of infant mortality and some selected age-specific mortality rates.

Table 2. Ninety-five per cent confidence limits for selected age-specific mortality rates at various sizes of random sample

	Age group (years)									
	Infant mortality		1-4		30-34		45-49		60-64	
Assumed proportion of total population (k)	Births at 45 per 1,000		0.13		0.06		0.04		0.02	
Assumed approximate mortality rate per 1 000 population (R)	150		30		10		15		40	
Sample size	2 σ a/	200 σ/R b/	2 σ a/	200 σ/R b/	2 σ a/	200 σ/R b/	2 σ a/	200 σ/R b/	2 σ a/	200 σ/R b/
50 000	±15.1	±10.1	±4.2	±14.1	±3.7	±36.9	±5.4	±36.3	±12.4	±31.0
100 000	±10.7	± 7.1	±3.0	±10.0	±2.6	±25.7	±3.8	±25.7	± 8.8	±21.9
150 000	± 8.7	± 5.8	±2.4	± 8.1	±2.1	±21.0	±3.1	±21.0	± 6.8	±17.0
200 000	± 7.5	± 5.0	±2.1	± 7.1	±1.8	±18.2	±2.7	±18.2	± 6.2	±15.5

a/ Expressed in per mill points.

b/ Expressed as percentage of the assumed rate.

These figures relate to the age-specific mortality rates of both sexes combined. If it is desired to obtain rates with the same confidence intervals as above but for males and females separately, the sample sizes should be doubled. It should also be observed that such age-specific mortality rates are specially liable to large non-sampling errors due to age misreporting, both in relation to the deceased persons and with respect to the base population.

In order to obtain even fairly rough approximations of adult age-specific mortality rates, therefore, very large samples are needed - so large, in fact, as to be beyond the resources of many developing countries, and to risk jeopardizing the efficiency of the field-work, vitiating the results by increases in the non-sampling errors. An alternative approach would be to design the survey to produce results that would facilitate the selection of appropriate model life-tables. 1/

1/ For further discussion of the various types of model life tables available, see Chapter 12.

If reliance is to be placed on the use of a single one-parameter model life-table, such a model could be selected simply on the basis of the crude death rate. This approach has, however, certain disadvantages. First, various types of one-parameter models are now available. The system developed by Coale and Demeny, for example, comprises four different "families" of one-parameter models, each with a rather different pattern of age-specified mortality; models could be selected from any one of these families which would give crude death rates similar to those obtained for the population under investigation, but there would be no means of knowing which family would provide the best representation of age-specific mortality. Secondly, there is increasing evidence to suggest that mortality patterns in many developing countries cannot be adequately represented by a single one-parameter model. While the levels of infant and child mortality may agree closely with those of a given model, the adult mortality rates may diverge widely.

These difficulties may be overcome either by splicing together various parts of different one-parameter models - e.g., taking the infant and child mortality rates from one model and the adult mortality rates from another - or, what is mathematically the more elegant approach, by making use of two-parameter model life-table systems such as those developed by Brass or Ledermann. For these purposes, a considerable advance would be achieved if the vital-rate survey were to provide valid estimates of mortality rates for two age groups only - those under and those over 5 years of age. This division has several advantages. In many developing countries, it will divide the annual deaths approximately in half, thus tending to minimize sampling errors; furthermore, the death rate for children under 5 years of age may be checked against estimates obtained from retrospective questions, asked of women enumerated in the survey, as to the total number of children born alive and how many of those children had survived to the date of the enquiry. Thus, the 95 per cent confidence limits associated with various sizes of sample for estimate of mortality rates for these two age groups are shown in Table 3.

Table 3. Ninety-five per cent confidence limits for mortality rates of population under and over five years of age at various sizes of random sample

	Age group (years)			
	0 - 4		5 and over	
Assumed proportion of total population (k)	0.17		0.83	
Assumed approximate mortality rate per 1 000 population (R)	60		12	
Sample size	2σ a/	$200\sigma/R$ b/	2σ a/	$200\sigma/R$ b/
50 000	± 5.2	± 8.6	± 1.1	± 8.9
100 000	± 3.6	± 6.1	± 0.8	± 6.3
150 000	± 3.0	± 5.0	± 0.6	± 5.2
200 000	± 2.6	± 4.3	± 0.5	± 4.5

a/ Expressed in per mill points. b/ Expressed as percentage of the assumed rate.

Table 4. Ninety-five per cent confidence limits for age-specific fertility rates at various sizes of random sample

	Age group (years)						
	15–19	20–24	25–29	30–34	35–39	40–44	45–49
Assumed proportion of total population (k)	0.052	0.044	0.037	0.031	0.026	0.022	0.018
Assumed approximate fertility rate per 1,000 population (R)	110	280	290	240	180	90	20

Sample size	2 σ a/	200 σ/R b/	2 σ a/	200 σ/R b/	2 σ a/	200 σ/R b/	2 σ a/	200 σ/R b/	2 σ a/	200 σ/R b/	2 σ a/	200 σ/R b/	2 σ a/	200 σ/R b/
50 000	±12.3	±11.1	±19.1	± 6.8	±21.1	± 7.3	±21.7	± 9.0	±21.3	±11.8	±16.4	±20.4	±9.3	±46.7
100 000	± 8.7	± 7.9	±13.5	± 4.8	±14.8	± 5.1	±15.3	± 6.4	±15.1	± 8.4	±11.6	±14.5	±6.6	±33.0
150 000	± 7.1	± 6.5	±11.0	± 3.9	±12.2	± 4.2	±12.5	± 5.2	±12.3	± 6.8	± 9.4	±11.8	±5.4	±27.0
200 000	± 6.2	± 5.6	± 9.6	± 3.4	±10.5	± 3.6	±10.8	± 4.5	±10.7	± 5.9	± 8.2	±10.2	±4.6	±23.2

a/ Expressed in per mill points.

b/ Expressed as percentage of the assumed rate.

Since births outnumber deaths in most developing countries, and the process of childbearing is concentrated in a relatively narrow age span of the female sex, age-specific fertility rates are generally higher than age-specific mortality rates and are therefore subject to lower coefficients of variation Table 4 shows the relationship between sample size and the confidence intervals for some age-specific fertility rates.

Some demographic surveys aim to obtain fertility rates not only by age group of mother but also by birth order - i.e. whether the birth is the mother's first, second, third, etc.. Such data are desirable not only because they throw greater light on the trends and patterns of fertility, but also because they permit considerable refinement of the correction procedures inherent in the comparison of cumulated current fertility with average parity. This more refined breakdown will of course be subject to larger sampling errors on account of the smaller numbers of births in each of the relevant cells. Table 5 shows confidence limits of some typical first-birth fertility rates. The sampling errors of fertility rates of higher birth orders will of course be larger, since the numbers of births decrease with ascending birth order. It will be seen that, given a random sample of 100 000, the estimated rates for the first two age groups (which are generally those of crucial importance) will be subject to a confidence interval of the order of ± 10 per cent. Although not large in itself, this margin of error may be appreciable when seen in relation to the difference between the cumulated rates and the corresponding proportions of women with equivalent minimum parity.

Table 5. Ninety-five per cent confidence limits of age-specific first-birth fertility rates at various sizes of random sample

	Age group							
	15-19		20-24		25-29		30-34	
Assumed proportion of total population (k)	0.052		0.044		0.037		0.031	
Assumed approximate fertility rate per thousand (R)	72		70		33		5	
Sample size	2σ	200 σ/R	2σ	200 σ/R	2σ	200 σ/R	2σ	200 σ/R
50 000	±10.1	±14.1%	±10.9	±15.5%	±8.3	±25.2%	±3.6	±71.6%
100 000	± 7.2	± 9.9%	± 7.7	±11.0%	±5.9	±17.8%	±2.5	±50.4%
150 000	± 5.9	± 8.1%	± 6.3	± 9.0%	±4.8	±14.5%	±2.1	±41.2%
200 000	± 5.1	± 7.1%	± 5.4	± 7.8%	±4.2	±12.6%	±1.8	±35.6%

An important demographic parameter that is frequently required is the mean of the age-specific fertility distribution. This parameter is of value for refining fertility estimates based on comparisons of age distributions with stable population models, for adjusting cumulative age-specific fertility rates so as to render them comparable with mean numbers of live births per woman, for deriving life-table functions of infant and child mortality from proportions of surviving children by age of mother, and for computing mortality rates of adult females from proportions of surviving mothers. It is also closely associated with the mean length of generation, which has an important influence on the rate of population growth. The sampling error, in years, of this mean may be calculated approximately from the formula:

$$\sqrt{\frac{\sigma_{fi}^{2} \cdot a_i^{2}}{f_i}}$$

where σ_{fi}^{2} = the variance of the fertility rate f_i;

and a_i = the mid-point of the i^{th} age group.

Using the fertility rates and their variances from Table 4, the confidence limits of the estimated mean (29.3 years) associated with various sample sizes are shown in Table 6.

Table 6. Ninety-five per cent confidence limits for the mean of the age-specific fertility distribution at various sizes of random sample

Sample size	2σ (years)	$200\,\sigma/m$ (percentage) a/
50 000	1.286	4.2
100 000	0.910	3.1
150 000	0.746	2.5
200 000	0.644	2.2

a/ m = 29.3.

C. Effects of departure from simple random sample

All the above formulae and tables assume simple random sampling. 1/ In practice such sampling is never used in household interview surveys. A real-life sample is likely to be (a) a multi-stage or cluster sample, (b) stratified,

1/ They would also apply if the events concerned were randomly distributed even if the sample were not.

and (c) selected by systematic rather than random sampling. Compared with a simple random sample, feature (a) will generally imply an increase in sampling error while (b) and (c) should mean a reduction. We consider these in turn.

Effect of clustering

If a random sample of areas is first selected and then a random sample of n persons is selected in each area, and if the areas are all assumed equal in population, then the sampling standard errors given in the above formulae have to be multiplied by

$$\sqrt{1 + (n - 1)\delta} \qquad \text{---(16)}$$

where δ is the intra-cluster correlation (see Section 7.1) for the variable concerned and for the size of area unit concerned. The factor under the square root sign is sometimes called the "design effect". If, as was recommended in Chapter 7, the survey covers all persons in each selected cluster, then n becomes the cluster size in terms of number of population.

The intra-cluster correlation δ measures the amount of variation between clusters compared with the amount within clusters. Thus, if people in the same cluster tend to be very much alike, and different from those in different clusters, δ will be high. (See Section 7.1 for an exact definition.) 1/ In practice, δ is a function of several different factors:

(i) The variable considered. For fertility it is very low, for mortality somewhat higher and for migration higher again, though still quite low. For educational and occupational characteristics it becomes much higher. For ethnic and language characteristics it would come close to the maximum.

(ii) Cluster size. Generally the larger the cluster size the lower the value of δ, but the decrease in δ is likely to be slower than the increase in n, so that δ n, and hence the design effect, is likely to increase slowly with increasing cluster size. Thus larger clusters normally involve higher sampling errors.

(iii) The population considered. Even for the same variable and the same cluster size, δ will not necessarily be the same in one country or region as another.

(iv) The stratification. If stratification is very detailed, the population in each stratum will be relatively homogeneous. This will lead to lower values of δ than if stratification is very broad.

1/ δ is necessarily between $-1/(n-1)$ and $+1$. When $\delta = 0$ the feature is distributed randomly. When $\delta > 0$ there is some tendency for the feature to be clustered - that is, neighbours tend to be more alike than people living further away from each other. When $\delta = 1$, all members of any given cluster are identical on the variable considered but there is still variation between clusters.

Values of δ have been estimated in several African surveys and censuses.1/ For clusters of a few hundred population and fairly detailed stratification some typical values are :

Crude birth rate	.001 - .003
Crude death rate	.002 - .004
Migration rate	.005 - .01
Adult male employment rate	.1

(For the first three rates above it is assumed that n is measured in terms of the number of people; for the last, in terms of the number of adult males). Very rough figures of this kind are all that we have at present for advance estimation. If clusters are very large we can assume smaller values. Also if the population is thought to be unusually homogeneous we can assume values at the smaller end of the above ranges. Such reasoning leads to a guessed value of δ which, with the cluster size n, can be inserted in formula (16) to give the design effect. This is then multiplied by the value of 0 as given, for example, in formula (10), (11) or (12) to give an advance estimate of the sampling standard error.

No data are available at present on values of δ for age-specific rates. They seem likely to be lower than for crude rates. Since in addition the value of n will be lower (the number of relevant persons in the sample per cluster) it is perhaps reasonable to assume that the design effect will be very close to 1, unless very large clusters are used. Thus, for age-specific rates the sample may in most cases be taken as effectively random. Formula (12) may then be applied directly, with R as the rate per thousand persons in the age group (or per thousand females in the age group in the case of age-specific fertility), and n as the expected number of persons (or females) in the age group.

Stratification

Stratification should, if successful, lead to an increase in homogeneity within the strata, which implies a lower value of δ. In practice in Africa this effect is not likely to be very substantial. However if very large strata are used (for example, the individual states of Nigeria) it would be advisable to assume somewhat larger values of δ than those quoted above. If ethnic stratification is combined with geographical stratification this should be more effective than either alone; the smaller end of the ranges quoted above may be taken to correspond to very detailed ethnic and geographical stratification.

1/ Many more estimates of this kind are needed. Annex 2 gives formulae for computing δ from survey results. Survey designers might reasonably regard it as a moral obligation to undertake and publish such computations as a service to their successors.

Systematic sampling

Systematic sampling means selection at a fixed interval in the sampling frame, from a random starting point.

Compared with random sampling, systematic sampling has the same effect as stratification in so far as the sampling frame is arranged in order, with respect to the variable concerned. For example, if the area units are grouped under ethnic headings in the list from which they are going to be sampled, then systematic sampling will give a good ethnic stratification. If they are grouped geographically, for example by province and district, then there will be good geographical stratification - which is another way of saying that we will ensure a good geographical spread in the sample. As with true stratification, in the context of an African demographic survey the effect of systematic sampling on the sampling errors of the vital rates is not likely to be very large. 1/

8.4 ESTIMATION OF SAMPLING ERROR AFTER THE SURVEY

The survey results when published consist of a number of estimates of rates, percentages, totals, etc. Each such estimate is subject to uncertainty due to sampling error. The sampling standard error is a measure of this uncertainty and it is desirable to publish such standard errors together with the estimates.

Sampling theory enables such standard errors to be estimated from the survey results in most cases, provided one knows the sample design and the estimation formula used. In Chapter 7 we considered possible sample designs; in Section 8.2 we considered the choice of estimation formulae. In this section we give the formulae for estimating (after the survey, on the basis of the data obtained) the sampling standard errors of the estimates whose formulae have been quoted in Section 8.2 above. Unlike the situation which exists in advance estimation before the survey, we are now interested in good estimates of sampling error rather than rough approximations.

Assuming that the estimation formula has been chosen and the sample design is known, the first essential is to determine whether we have a simple estimate or a ratio estimate. 2/ As we have already seen, a ratio estimate is one whose formula involves the ratio of two quantities both of which are subject to sampling error. Some simple estimates are indeed ratios, but the denominator is a constant, so they are not ratio estimates.

1/ Very occasionally, systematic sampling can cause an increase in the sampling error. This may happen if the sampling frame contains a regularity which coincides with the fixed sampling interval. In area-sampling in Africa this can only happen, in practice, if one is sampling blocks from a town which has a regular grid lay-out. In such a situation, random sampling is safer.

2/ These are not the only possible alternatives but they are by far the most common. The "simple estimate" is often called the "unbiased estimate". It involves simply multiplying the sample result by a constant. We include here in the term "ratio estimate" an "estimate of a ratio" - the two are often distinguished in textbooks.

We assume first an unstratified equal-probability single-stage cluster sample. Thus m clusters are assumed to have been selected with equal probability from a universe of M clusters, and the survey covers all persons in each selected cluster. Suppose in the i-th cluster we find totals y_i and x_i, the sample means per cluster being

$$\bar{y} = \frac{1}{m}\sum y_i \text{ and } \bar{x} = \frac{1}{m}\sum x_i$$

We begin with the ratio estimate. If the ratio of y to x in the universe is estimated by the formula:

$$\hat{R} = \sum y_i \Big/ \sum x_i = \bar{y} / \bar{x} \qquad \text{—(17)}$$

then the estimate R has an estimated sampling standard error:

$$\sigma_{\hat{R}} = \frac{1}{m\bar{x}} \sqrt{1 - \frac{m}{M}} \sqrt{\frac{M}{M-1}} \sqrt{\frac{m}{m-1}} \sqrt{\left[\sum y_i^2 - 2\frac{\bar{y}}{\bar{x}}\sum y_i x_i + \frac{\bar{y}^2}{\bar{x}^2}\sum x_i^2\right]} \qquad \text{—(18)}$$

the summations being taken over the selected clusters.

Note. The three correction factors shown here under square root signs are often ignored in practice. The first, $\sqrt{1 - m/M}$, may be written $\sqrt{1-f}$, where f is the sampling fraction. When f is small, say less than 0.05, this is usually ignored. The second, $\sqrt{M/(M-1)}$, can nearly always be taken as 1. These two are often written together as

$$\sqrt{\frac{M - m}{M - 1}}$$

and called the "finite population correction". The third, $\sqrt{m/(m-1)}$, is the "small sample correction". It is often ignored if m (here the number of sample clusters) is over 20.

This basic formula covers virtually all that the practical survey technician needs to know in order to estimate standard errors. We have deliberately started with this relatively complicated case of the ratio estimate because all the other cases normally encountered can be obtained as special cases of this.

Thus, suppose we are estimating a mean $\bar{Y}$, using the sample mean $\bar{y}$ as the estimation formula. In symbols:

$$\hat{\bar{Y}} = \bar{y} \qquad \text{—(19)}$$

Comparing this with formula (17), we see that it is obtained from (17) by putting $\bar{x} = 1$. Since the estimate is not affected by variation in x, we put every x_i equal to 1 in formula (18). It is then easily seen that we obtain for the sampling standard error of the above estimate:

$$\sigma_{\hat{\bar{y}}} = \frac{1}{m}\sqrt{1 - \frac{m}{M}}\sqrt{\frac{M}{M-1}}\sqrt{\frac{m}{m-1}}\sqrt{\left[\sum y_i^2 - m\bar{y}^2\right]} \qquad \text{—(20)}$$

Note. The expression in square brackets on the right can also be written:

$$\sum (y_i - \bar{y})^2$$

We now recall two simple rules:

(I) Adding a constant to an estimate does not affect its standard error.

(II) Multiplying an estimate by a constant means that its standard error has to be multiplied by the same constant.

In symbols: If $\hat{Y}' = A\hat{Y} + B$

then $\sigma_{\hat{Y}'} = A\,\sigma_{\hat{Y}}$

Using these rules we can easily find the standard error of any of the estimates quoted in Section 8.2 For example, the estimate (4) is estimate (19) above multiplied by the constant 1000 M/N'. Its sampling standard error is therefore given by the formula (20) multiplied by this same constant. Similarly, the population estimate (6) has sampling standard error given by multiplying formula (18) by N' and replacing y by n and x by n'.

As for the difference estimate (7), using the form (7') and applying (20) above, we obtain immediately for the standard error:

$$\sigma_{\hat{N}} = \frac{M}{m}\sqrt{1-\frac{m}{M}}\sqrt{\frac{M}{M-1}}\sqrt{\frac{m}{m-1}}\sqrt{\left[\sum (n_i - n_i')^2 - m(\bar{n}-\bar{n}')^2\right]} \qquad \text{—(21)}$$

Turning now to other sample designs, we consider the special cases mentioned in the preceding section.

(a) Stratification

This is covered by rules (I) and (II) above, together with the formula:

$$\sigma_{x+y} = \sqrt{\sigma_x^2 + \sigma_y^2}$$

which applies provided x and y are estimated from different samples or are uncorrelated.

Thus, a composite weighted estimate such as formula (8) above, namely

$$\hat{R} = \frac{N_1\hat{R}_1 + N_2\hat{R}_2 + \ldots}{N_1 + N_2 + \ldots}$$

has sampling standard error

$$\sigma_{\hat{R}} = \frac{N_1^2 \sigma_{R_1}^2 + N_2^2 \sigma_{R_2}^2 + \ldots}{N_1 + N_2 + \ldots}$$

It is in stratified samples that the small sample correction $\sqrt{m/(m-1)}$ becomes particularly significant. It will be seen that, with (m-1) in the denominator, the sampling error formulae break down if m = 1. Thus it is not possible to estimate sampling error rigorously unless we have at least two selected units per stratum. If only one has been selected in a certain stratum, the usual strategy is to group this stratum with a neighbouring one ("collapsing of strata") before computing the standard error; we then normally get a slight overestimate of the sampling error.

If a "combined" ratio estimate is used - i.e. if the ratio is obtained for a domain covering more than one stratum - the estimate will take the form shown in formula (9), namely:

$$\hat{R} = k \quad \hat{Y}_h \; / \; \hat{X}_h$$

Here $\hat{Y}_h$ and $\hat{X}_h$ are the estimated totals of y and x in stratum h, so that $\hat{Y}_h = w_h \sum y_i$ and $\hat{X}_h = w_h \sum x_i$ for some appropriate set of weights w_h which will be known. Thus, in formula (18) we can replace each y_i by $w_h y_i$ and each x_i by $w_h x_i$. This leads to:

$$\sigma_{\hat{R}} = \frac{k}{m\bar{x}} \sqrt{1 - \frac{m}{M}} \sqrt{\frac{M}{M-1}} \sqrt{\frac{m}{m-1}} \sqrt{\left[\sum_h \left\{ w_h^2 \left(\sum_i y_{hi}^2 - 2 \frac{\bar{y}}{\bar{x}} \sum_i x_{hi} y_{hi} + \frac{\bar{y}^2}{\bar{x}^2} \sum_i x_{hi}^2 \right) \right\} \right]}$$

where $\bar{y} = \frac{1}{m} \sum_h \sum_i y_{hi}$ and $\bar{x} = \frac{1}{m} \sum_h \sum_i x_{hi}$

The quantities m and M may be taken as referring to the whole domain concerned as if there were no stratification, although the correction factors are now only approximately correct.

(b) Cluster sampling with variable probabilities

We have seen above how in the estimation process this sample design involves multiplying each observed quantity by the factor $m/(M p_i)$, where p_i is the cluster selection probability. The same operation can be applied to the sampling error formulae already quoted and this is all that is necessary to cover the case of variable sampling probabilities. The same adjustment must be applied in computing the cluster means $\bar{y}$, $\bar{n}$, etc..

(c) Multi-stage sampling

As long as the sampling fractions remain constant within any given stage, then to an adequate degree of approximation all the same formulae apply to the case of multi-stage sampling, assuming that M and m still refer to first-stage units and the quantities y_i, n_i etc. refer now to the estimated totals for the i-th first-stage sampling unit. 1/ (For example, in two-stage sampling, if f_2 is the second-stage sampling fraction, then the observed quantities in each cluster must be multiplied by f_2 before being inserted in the formulae). In other words, the second and later stages of sampling can be ignored for purposes of computing the sampling error. 2/

(d) Systematic sampling

Methods exist for estimating the sampling error for systematic sampling but they are cumbersome and are seldom used. The normal procedure is to apply the formulae for stratified random sampling and then to argue simply: since we have used systematic sampling our sampling errors should be slightly better than those computed. In African applications the gain from systematic sampling is likely to be small and this appears a reasonable approach.

Summary

Choice of an estimation formula. Several factors have to be considered for estimation of rates; in the majority of cases the simplest assumption is likely to be the best: assume that the rate found in the survey sample applies to the whole population. For estimation of an absolute number, a ratio estimate using supplementary information from the census (method vi) will often be the best.

Estimation of sampling error in advance of the survey. It is recommended to begin by assuming a simple random sample and to estimate the sampling standard error σ_o from formulae (10) - (15) as appropriate. Then guess the intra-cluster correlation δ from evidence of other surveys and compute the "root design effect" (16). Multiply this by σ_o to obtain the estimated sampling error for the planned sample.

1/ The "approximation" referred to here involves the assumption of sampling with replacement. In reality we are likely to use either sampling without replacement or systematic sampling.

2/ The explanation is that the variation due to the second and later stages of sampling is reflected in the x_i, y_i, n_i, etc. obtained, which vary more than they would have done if there had been total coverage at these stages. This variation is then automatically taken into account when these values are used in the formulae.

Estimation of sampling error after the survey. Formula (18) covers almost all that is needed in practice. Every common case can be deduced as a special case of this formula.

References

See references at end of Chapter 7.

CHAPTER 9

ORGANIZATION AND FIELD WORK

This chapter covers only independent sample surveys. It does not seem useful to try to include sample operations which are an integral part of a census (such as the post-enumeration survey and the "built-in" census sample). Such operations will depend for their organization on the census itself - obviously a much larger operation - and to discuss this would take us far outside the scope of the present manual. Nevertheless, much of what is said in this chapter applies also to censuses.

Once the objectives have been fixed (in Chapter 1 we suggested that they should be embodied in a draft list of tabulations required), the first step in detailed planning of a survey is to draw up a precise plan of operations and an estimate of costs. Costs depend above all on two factors: the sample size and design, already discussed in Chapters 7 and 8, and the nature of the field operations - numbers of personnel, recruitment, training, duration of field work, transportation. In this chapter, therefore, we discuss problems of field work first, and later the question of planning and costing the survey.

9.1 FIXING THE MAIN FEATURES OF THE SURVEY

Type of survey

We have already discussed in Chapter 3 how a choice has to be made between three main types of operation:

(a) The single round survey
(b) The multi-round survey
(c) The dual record system (PGE)

Obviously this choice is fundamental and must be made at an early stage of planning. Some factors affecting the choice will be discussed in Chapters 11 and 12.

Mobile teams versus fixed enumerators working singly

Some African demographic surveys have been organized in such a way that the field work, for any given round, is completed in the shortest possible time. Examples are the Nigerian demographic survey of 1965-66 and the Ghana Population Survey of 1966. In this system each enumerator is allocated one village or primary sampling unit "PSU". There is therefore a large force of field workers and supervision is less strict. The alternative system, widely used in French-speaking African countries, is to use a small force of enumerators divided into a few teams, each closely supervised by a well trained team leader. The team works together in each sample PSU (each member is given one part of the village, or one hamlet) and when they have finished they move together to another PSU. The work may extend over a period of several months, though in many cases a single team cannot operate over a very large area for linguistic reasons.

The first system produces data which are more convenient for the demographer since the whole area of inquiry is covered simultaneously (although there is the disadvantage that seasonal trends are not allowed for). In the team system there may be difficulties in interpreting the findings through confusion between seasonal movements of the population and movements of the interviewing teams. Moreover the number of man-hours, and probably the amou of money, spent on transportation is greater with the mobile team arrangemer so that for a given budget the sample which can be covered is smaller. On t other hand, the team method should lead to a higher standard of field work. The supervisor is in daily touch with every member of his team; he can check the questionnaires before leaving the PSU and in the case of defective data can arrange a return visit to the household. Moreover the small size of the total field force makes it possible to apply stricter standards in the recru ment of both enumerators and supervisors, besides making training easier. Finally, in many surveys the main bottleneck is in the number of professiona supervisory staff available; with the mobile team system it is possible for each such senior officer to supervise a larger amount of field work since th work is spread over a longer time.

It sometimes happens that enumerators insist on working in groups becau of an anticipated unfavourable reaction of the local population.

An early decision has to be made for the mobile team or the fixed individual method of working, which affects recruitment and training of field staff, the survey time-table and the budget.

A compromise system is, of course, possible: enumerators may work singly but each may cover a number of PSUs in succession. Or supervisors may move successively from one area to another but recruit new fixed enumerators for each area. Each of these systems has been used in Africa.

Structure and size of the survey organization

A simple hierarchical structure is usual for carrying out field surveys. At the top is the survey director, who should have full executive powers once the survey plan has been agreed. More than one demographic survey in Africa has run into difficulties because no single person was clearly designated to take ultimate responsibility for the survey. Further, it is important to note that even the smallest demographic survey is an elaborate operation and needs a full-time director.

Under the survey director there will be sections responsible for field work, data processing, and administration. The two latter will in most cases be already-existing units within the statistical office which merely lend their services to the survey while continuing their normal work. The arrange ments here will depend on the organization of the statistical office and little can be said about them in this manual.

Turning to the field work section, this may be either a permanent unit or an organization specially set up for the survey. In either case it will consist, generally, of at least three levels of personnel: field organizers (the term used is variable), supervisors and enumerators. The field organize are generally qualified statisticians or junior statisticians. In small

surveys with team enumeration there may be no more than two - in some such cases the survey director has also acted in this capacity. Where enumerators operate individually in fixed locations the field organizers usually become regional officers each responsible for a group of perhaps 5 to 10 supervisors. The supervisors (whose duties are described in a later section) in turn are each responsible for from 5 to 10 enumerators; 5 is perhaps the commonest figure and 10 is probably too high for effective supervision.

Is is probably true to say that the success of a survey depends more on the competence and energy of the field organizers than on any other single factor.

Other workers include drivers, and in many cases guides who are recruited by the enumerators in each village and paid a small honorarium.

In dual record operations (PCE) there will also be registrars (who normally report to regional officers) and in most cases sub-registrars (who report to registrars).

The numbers of personnel to be employed at each level depend above all on the sample size and the planned duration of field work. An average rate of working in African demographic surveys would seem to be from 5 to 10 households per enumerator per day. In average conditions the lower figure would represent the overall rate (inclusive of travel time, holidays, sickness, call-backs, but not listing or mapping), while the upper figure would correspond to the rate of working on a day in which the enumerator is actually interviewing full time. In planning a survey one might take these figures as a starting point and then allow for any mapping or listing operations, special geographical problems, and national experience with other surveys. A particularly important consideration is whether enumerators can conduct interviews throughout the day or whether they must wait until the household head returns from work (see Section 9.4, "Ensuring that a respondent will be present"). In the latter case the rates of working given above would be much too optimistic.

Transportation of field workers

Four main means of transport have to be considered:

Cars specially provided for the survey
Public transport
Bicycles (powered or pedal)
Walking 1/

In the first category, such vehicles may be purchased specially for the survey or they may be allocated from a pool. The second category includes buses, lorries and rural taxis. Bicycles may be purchased by the survey organization and allocated to enumerators or the survey may advance money to the enumerator to purchase a bicycle with an allowance for depreciation. The latter system encourages enumerators to take better care of their machines. The system has been used occasionally for cars for senior survey staff.

1/ Other means of transport which have been used in African surveys include aircraft, horses, mules and canoes.

The arrangements made for transport, and the budget allocation, have varied very widely in African surveys. In some surveys every supervisor has been allotted a car; at the other extreme some surveys have relied almost entirely on public transport. Obviously these differences reflect, at least in part, the wide differences in the facility of transport in different countries. Some countries have a well developed network of small feeder roads, others do not. In some countries there are many buses and passenger lorries; in others there is nothing between the two extremes of the freight lorry, plying only the main routes, and the rural taxi, willing to go anywhere but at a high price per passenger-kilometre. Finally, and obviously, the terrain varies widely from one area to another so that bicycles may or may not be useful. When all these differences have been taken into account, the impression remains that some survey planners have adopted a very much more liberal - not to say extravagant - approach to the transport problem than others. As transport is generally one of the larger items in the survey budget, the problem deserves careful attention.

Conditions vary so much that generalization on the transport problem is risky, but on the whole African experience does not seem to justify the more expensive arrangements adopted in some countries. The following principles are suggested as a guide:

(1) Public buses or lorries should be used wherever possible.

(2) Cars should not be allocated below the level of regional officers or field organizers.

(3) Assuming fixed enumerators and mobile supervisors, if local transport is inadequate, powered bicycles should be sufficient for the supervisors in most types of terrain.

(4) With mobile enumeration teams, if local transport is inadequate, a car is necessary to transport the team from one PSU to another. However, a single car should be able to service several teams.

(5) Where the enumeration area is very dispersed the enumerator may be supplied with a bicycle, but it is rarely justifiable to allocate bicycles automatically to every enumerator.

Finally, it should be noted that whenever individual transport is allocated to an enumerator, even a bicycle, it tends in practice to encourage him to obtain accommodation <u>outside the enumeration area</u> - for example, in the nearest town. Inevitably this reduces the amount of field work done. It may not be too much to say that, at least where enumerators work singly, the transport policy adopted should be such as to <u>discourage</u> the enumerator from travelling. The supervisor, on the other hand, needs to be <u>encouraged</u> to travel.

The method of paying enumerators for use of commercial transport is discussed in Section 9.2 below.

Fixing the dates of the survey

The timing of the various survey operations usually starts from a decision as to the dates of the field work (for details, see Section 9.10 "Planning the Survey"). Various factors affect the choice of field work dates. Some of these are general in nature - the urgency of the demand for the results of the survey, the availability of finance, etc.. Others are more specific and affect the choice of particular dates or periods; the main such considerations are listed below.

(a) Avoid the rainy season (however, there are many areas in which this is not an important consideration)

(b) Avoid periods of intense agricultural activity

(c) Avoid periods of heavy seasonal migration

(d) Choose a period of school vacation if teachers or school children are to be used as field workers.

(e) Avoid important festivals or periods of fasting (Christmas, Ramadan) when normal routines are upset. Even avoid end-of-month pay days if practicable.

Factors (d) and (e) affect the choice of the period for training field staff as well as the field work period itself.

The factors listed above are particularly worth attention where field work is planned to last for a short period only. But they should also be considered even for surveys spreading over a long period; it may be decided for example, to withdraw the field workers temporarily during the rainy season and have them work in the office, perhaps coding the data already collected. The same principle applies to multi-round surveys and dual record systems: in these, the survey normally covers the whole year, but it is possible to arrange for gaps between the end of one round and the start of the next and this may be desirable to avoid very heavy rains, Ramadan, etc..

Sometimes the dates which are suitable in one part of the country are unsuitable in another. This may favour the use of mobile teams, whose movements can be phased appropriately.

9.2 RECRUITMENT AND REMUNERATION OF FIELD WORKERS

Recruitment

Many countries possess a permanent corps of enumerators employed by their statistical office. For such countries the problem of recruitment does not arise and the present section will not apply.

There are two main ways of recruiting the required field workers: the job may be offered as part-time or vacation work to a limited category of employees or students, or recruitment may be made by advertisement and competition on the open market.

Except for purely urban surveys, part-time enumerators are of little use in a demographic survey. On the other hand vacation workers can be usefully engaged. Where this system has been adopted the work has been offered, in most cases, to primary school teachers or secondary school children. (Census enumerators are sometimes recruited from among civil servants but this is not usual for sample surveys). There is a widespread consensus, in both developing and developed countries, that university students do not make good field workers; they are less ready to accept instructions and tend to object both to the physical hardship and the mental drudgery of the enumerator's job. Obviously vacation workers can only be used if the field work is of short duration. This in itself is an important limitation but perhaps equally important is the inflexibility in timing which results. If often happens that field work is delayed in starting or is completed less quickly than expected. If vacation workers have been employed one may then be forced to accept incomplete coverage of the sample, with a resulting bias of unknown size.

Recruitment of enumerators on the open market avoids these disadvantages, besides in many cases yielding a more highly motivated corps of field workers.

It is usual to fix an educational requirement (typically corresponding to 8-10 grades of schooling) and then to apply an aptitude test. The latter may consist of a few simple addition and subtraction sums, some clerical ability items, and some comprehension/reasoning questions.

Examples of clerical ability items are the following:

1. Make a circle round every 8 in the list below:

   2168580865174
   4638903185632
   7192469268471

   How many sixes are there in the list?

2. This sentence is written backwards below with one mistake

   ekatsim eno htiw woleb sdrawkcab nettirw si encetnes sihT

   Make a circle round the mistake.

Examples of comprehension/reasoning questions are the following:

1. A man had three children by his first wife; two of these were boys of whom one died, the other was a girl. By his second wife he had four children; one was a girl and the rest boys and all are alive. He has no other children.

   How many sons does he have living?

2. A man said yesterday that his wife had a baby "two days ago". Tomorrow is October 2nd. On what date did she have the baby?

Once the educational qualifications and the test have been decided, it is useful to have the procedure formally approved by a relatively senior official (such as the chief government statistician or the agency responsible for civil service recruitment regulations). It sometimes happens that improper pressure is brought on the survey director to recruit a particular individual; if the procedure for recruitment has been officially laid down he can point out that he is bound by this and is unable to do more than admit the candidate to the test.

It is advisable not to set a definite pass-mark in advance for the test but to accept candidates in order of their test score until the number of recruits needed has been reached. Nevertheless the survey organizer should have some idea of the minimum standard below which candidates cannot possibly be accepted. In other words, there should be a minimum pass-mark but if too many reach this mark they need not all be accepted.

Before final acceptance, potential recruits should be interviewed since there are other important qualifications besides intelligence and educational level. The following extract from the "Notes for supervisors" for the 1969 Population Census of Uganda is worth quoting.

> "It is essential that the right sort of persons should be recruited as enumerators; do not take someone on just because he is a friend or a relative, or because some influential person has asked you to employ him. An enumerator should have the following qualifications:
>
> He should be sufficiently literate and well educated to understand the form and fill it in accurately;
>
> He should be physically fit - capable of walking round his area and not likely to go sick at the last minute or in the middle of the work;
>
> He should be the sort of person who will do the work honestly and conscientiously - some enumerators have been known (in censuses all over the world) who have just sat down under a tree and filled up the forms out of their heads; we do not want this sort of person as an enumerator for the Uganda census; nor do we want the sort of person who is liable to get drunk, or who won't listen to the instructions and thinks he knows better than his supervisor and others who may be helping to teach him what to do;
>
> He should be tactful, polite and friendly; people may refuse to answer the questions if the enumerator is rude or tries to bully them."

More candidates should be recruited for the training course than are needed for the survey. In the first place one must allow for a certain amount of drop-out and, secondly, the training course itself is better than any test as a way of discovering those who are not good enough for the job. Finally, about 5 per cent of the trained field force should be kept in reserve for emergencies and this must be taken into account when recruiting. In most countries, <u>at least</u> 20 per cent excess should be allowed in recruiting for the training course. At the end of the course the required number of enumerators should be retained, starting with the best. Naturally, candidates

should be warned from the beginning that there will be some selection at the end of the training. They should also be informed of the pay scales both for the training period and the field work;

In the recruitment of supervisors the qualifications are similar though at a higher level. However, one additional qualification should be considered highly desirable; the candidate should have previous experience of census or survey work. Obviously this condition is more easily fulfilled where field workers are employed on a permanent basis, and there is no doubt that national statistical offices should, in the long run, aim at the establishment of such a permanent corps.

Note that, in most countries, before field workers can be formally engaged they will be required to sign an undertaking relating to secrecy in accordance with the statistical law. Having done so, they should be given an official card authorizing them to collect information for statistical purposes within the context of the survey, which should be specified as to title and approximate dates.

Basis of remuneration

In many cases the payment of field workers will be dictated by existing regulations and scales and where this is so the present section will be redundant.

Three main systems of payment of field workers are possible:

Fixed sum
Payment by days worked
Payment by interviews completed

The last of these seems to be rarely used and is not recommended, except in the unusual situation where a fixed list of the interviews required is available in advance.

Where field workers are recruited from among the unemployed and expect to return to unemployment after completing the survey, the method of payment by days worked offers a dangerously strong incentive to string out the work for as long as possible. In these circumstances, and particularly when the survey is of short duration, the fixed sum is to be preferred.

Where vacation workers are used and the dates of their work with the survey are limited by the extent of their vacation, the two methods of fixed sum and payment by days worked are almost equivalent. In most such cases, the fixed sum has been preferred: it is simpler and offers some incentive to complete the work ahead of time.

When the survey is of long or unpredictable duration - as it usually is with the mobile team method - payment by time worked is practically the only possibility.

Payment for the training period is usually by lump sum, at a somewhat lower daily rate than during field work. The sum is generally paid on completion of training.

Incentive payments, properly used, can do much to improve the field workers' performance. In many cases, however, they are ruled out by government regulations. Assuming they are allowed, they should be linked to the quality rather than the quantity of the work. For example, a bonus is fixed in advance and it is announced that gross errors will lead to non-payment of the bonus, other serious errors to half payment. By "gross error" is meant omission of several interviews. "Serious errors" includes blanks in the questionnaire, omission of one or two interviews, etc. It is unwise to draw up a rigid scheme since this can lead to arguments over its application; the decision to revoke, or halve, the bonus payment should be made by a field organizer or regional officer after examining each case.

It should be agreed with the appropriate authorities at the beginning, and emphasized to all field staff during their training, that wilful negligence or deliberate falsification is a serious offence and will entail immediate dismissal.

Where public transport is used, some arrangement has to be made for payment to enumerators to cover this expense. Experience shows that much time and worry can be expended on this and it is well worth fixing a procedure of maximum simplicity at an early stage of the planning. One method is to fix in advance the number of journeys to which each enumerator is entitled (two per PSU appears adequate, one there and one back), and to have the supervisor certify the fare per journey. It may be necessary to make an advance for travel expenses and this can be based on a rough estimate, any excess being recoverable from the final salary payment. In some countries it is possible to issue travel warrants. These specify the mode of transport and the two end-points of the journey. They can be issued in advance and this avoids the need to have cash changing hands in the field.

Supervisors' travel is inevitably more complex (except where the supervisor stays always with his mobile team), and there may be no alternative but to have each supervisor present a detailed travel expense claim. As supervisors are relatively few in number the resulting administrative work is acceptable. This problem is, of course, avoided where supervisors are provided with their own means of transport.

Almost all of the problems discussed above in this section are made simpler if the mobile team method is used.

Arrangements for payment

Getting their pay to the field workers is a problem in most African surveys. Firm arrangements should be made for this before field work starts.

If the survey is of short duration there may be no need to distribute any money in the field. At the end of training, enumerators are paid for the training period and given an advance for travel expenses, and perhaps a

small advance of pay for the field work period. On reporting back at the end of field work they receive the remainder of their pay, plus bonus if any.

If field work lasts much longer than a month, this system is inadequate and the usual arrangement is then to have the pay distributed by visiting field organizers. Since such visits are desirable in any case for the purpose of supervision, there is no additional expense involved. Moreover, by bringing the pay with him the field organizer can be fairly sure that every field worker will be present to meet him, and this in turn assists supervision.

9.3 TRAINING OF FIELD WORKERS

General remarks

Teaching is a skilled occupation. Most statisticians have no training in how to teach and, as a result, most of them are bad teachers. This situation cannot be remedied, but the following remarks are intended to help those who have to train field workers to avoid some of the simpler mistakes. Most of this advice sounds obvious and the reader may feel he knows it already; nevertheless, experience shows that the points below are constantly ignored in African survey training courses. In most African countries it is possible to find an expert who has specialized knowledge of teaching methods; besides attending to the points listed below, the survey organizer is strongly advised to consult such a specialist during the planning stage of the survey.

Size of class. A group of more than 20 trainees is always difficult to handle.

Classroom. The classroom should be large enough to allow trainees to be separated by a side-by-side distance of at least 1.5 metres (5 feet), otherwise they can read each other's work and testing is then useless. Rooms with concrete walls usually have bad acoustics and trainees may be unable to hear the teacher clearly. The simplest solution is to drape a few blankets against some of the wall space. It is surprisingly difficult to get untrained teachers to take this problem seriously, although it might seem obvious that if trainees cannot hear part of what is said, then training must be inefficient.

Equipment. At one stage of the training, it will be useful to display an enlarged representation of the questionnaire in front of the class and to write answers in the spaces (see below). The method of doing this should be considered in advance. If it is decided to use a blackboard, then it should be noted that a large blackboard will be needed - a portable board supported by an easel will not do. A better method, however, is to draw the questionnaire with a felt-tipped pen on a large sheet of paper or cardboard (about 1 m x 2 m, or 3 feet x 6 feet). This work can be done before training starts. If training is to be carried out simultaneously in several locations, one such sheet will be needed for each location and for each type of questionnaire. During the training session a stiff polythene (PVC) sheet is fixed in front of the questionnaire; one can then write with a coloured or black felt-tipped pen on this transparent sheet. If the pen uses a water-soluble ink such writing can be easily erased with a damp cloth. (Some felt-tipped pens are water-

soluble, others are not. This must be checked before ordering the pens). In this way the same questionnaire can be used again and again. Note that if this method is used it will still be necessary to provide a small blackboard for use in other parts of the course. Finally, plentiful supplies of pencils, paper and blank questionnaires will be needed.

Attendance. During classroom sessions, if any trainee is absent even for 10 minutes, this is a serious matter. Either he has missed something important or not. If not, the course must be badly designed. If he has, the missing material can only be supplied by the teacher; this will take 10 minutes of the teacher's time after class, for it takes just as long to teach one man as 20 men. This is therefore an extremely wasteful use of the teacher's time. It follows that the question of attendance should be taken very seriously. There should be frequent breaks (see below) but it should be understood that no trainee may leave the room between breaks. Late arrival should be penalized, if possible by a system of bonus payments for punctuality. No new work should be started as long as even one trainee is absent since it will only have to be repeated; if a trainee is late, it is more profitable to spend the waiting time recapitulating earlier work with the rest of the class. Again, the problem of attendance is one which inexperienced teachers find difficult to take seriously; they are inclined to let students wander in and out almost without noticing them. This is a serious mistake.

Discipline. While classroom discipline is extremely important, it is still more important for the teacher to keep his sense of proportion. In some training courses late arrivals have been "penalized" by being refused admittance to the session for which they are late. But this penalizes the survey more than the trainee. He is not being trained for his own benefit but because he is needed for the survey. However much he may be to blame, the only purpose of the course is to give him the best possible training and this aim must take absolute priority.

Length of sessions. Psychological research shows that more is learned if the training time is broken up into numerous short sessions than a few long ones, except where the breaks would clearly interrupt a train of thought of a complex nature. This is particularly true where the lecturing method is used; only the most exceptional lecturers can hold an audience's attention for more than 30 minutes. 3-5 minute breaks every half-hour may seem wasteful but in practice they more than repay the time lost.

Teaching method. The inexperienced teacher is inclined to believe that the best way of training is to tell people what to do. In fact, this is the worst way. A better way is to let them watch someone else performing, and the best way is to have them do it themselves. Learning is an active process. The student learns most when he is doing something, least when he is sitting listening. Where periods of lecturing are unavoidable, the lecturer should constantly interrupt himself to put questions to individual trainees. The detailed application of these principles is discussed in the section "Method of training" below.

Getting the proportions right. A common mistake of inexperienced teachers is to spend too much time on tricky problems of detail (definitions particularly) and too little on explaining the main lines of what has to be done.

The trainer should smake a conscious effort to resist this temptation. The problem is taken up again below.

Training by proxy. In censuses, training has to be done by the chain method: statisticians train the regional officers, who train the supervisors, who train the enumerators. This system should be avoided wherever possible; inevitably it leads to a steady fall in the quality of training as we go down the chain. In most sample surveys the number of enumerators for each senior staff is quite small so that all enumerators can be trained directly by qualified statistical personnel. Wherever this system is practicable it should be used.

Method of training

The training procedure recommended below is put forward on the basis of the experience of a large number of African demographic surveys. However, it is not claimed to be necessarily the best there is, and in any case modifications to suit local conditions are likely to be needed.

Training should be based on an instructional manual, a copy of which is issued to each enumerator. There are several advantages in this procedure. The manual helps to ensure that all the necessary points are covered in the training course, assists revision during the course, and serves the enumerator for reference purposes during field work. It also serves as a record of what has been taught; such a record is needed for the report of the survey. Finally, in the event that training is carried out in more than one course or is delegated to someone other than the author of the course, the manual helps to ensure that the desired material is taught to everyone.

A disadvantage of basing training on the manual is that the requirements of training and reference are different. Training should emphasize the main points, giving relatively little attention to details such as definitions. However, as a work of reference the manual must include the definitions and inevitably they take up a good deal of space. The best solution seems to be to put the definitions in a special section at the end of the manual; this helps to give them less emphasis in the training.

Although we have said that trainees learn most by actually performing the task, nevertheless one cannot avoid the use of lecturing in the earlier stages of training. We suggest that the training course should fall into four parts, which are detailed below. Note, however, that before beginning Part 1, it is useful to introduce the survey with a specially prepared demonstration interview. This helps to set the scene and to lend realism to the lectures which follow.

Part 1. The survey procedures are described in lectures, first in outline, then in detail. This part of the course follows the enumerator's manual detailed in the next section.

Part 2. A trainee comes to the front of the class and interviews the instructor. The questionnaire is sketched on the blackboard and the interviewer enters the responses on the board as if completing a questionnaire. Alternatively, the questionnaire is prepared in advance on a large sheet of paper

or cardboard and the interviewer writes in the answers on a polythene sheet fixed in front of it, as described above. When this has been done two or three times, the method may be modified by having one trainee interview another. A further variation is to have each trainee in the class enter the responses on a blank questionnaire - the interview still being conducted publicly at the front of the class. The completed questionnaires are later reviewed by the course instructor. Throughout these interviews comments and criticisms should be invited.

Part 3. Enumerators are transported to a nearby village where they conduct real interviews. Each must produce a specified minimum number (for example, 5) of completed questionnaires by the end of the day. These are reviewed by the course instructor, assisted by field supervisors, and returned to the trainee with critique. The instructors and supervisors should also observe as many interviews as possible. Tape recorders can be extremely useful at this stage. However it should be borne in mind that a taped interview takes as long to listen to as a live one; there is no point in collecting more tapes than the training staff can find time to listen to.

Part 4. Written tests. They may be introduced at various times in the course, once study of the manual is completed. They may take two forms:

(1) Questions testing knowledge of the instructions. It will be found quite difficult to devise questions whose answer is not obvious and yet which test useful items of knowledge. Two examples of unsatisfactory questions are the following:

(a) A man claiming to be the husband of a woman already interviewed comes to you after work and demands to see her questionnaire. What do you do?

(i) Punch him in the nose?
(ii) Show him the questionnaire?
(iii) Explain politely that the survey is confidential and you are not allowed to show the questionnaire to anyone?

If the incident actually occurred the enumerator might have no idea what to do, but presented with above alternatives, it is easy to see that (iii) is the right answer, if only because of the word "politely".

(b) A man gives his age as 140. What do you do?

Though the question is valid, it is of very little significance. Such cases are so rare that it is of little importance whether the enumerator knows what to do; almost any reasonable solution will be acceptable and can be put right if necessary at the coding stage.

Two examples of good questions are the following:

(c) A man tells you that he has never been to school. How do you complete the entry under "years of schooling":

(i) Leave it blank?
(ii) Write NIL?
(iii) Enter 0?

This is a very common case and if enumerators follow the agreed rule it will save much time at the coding stage.

(d) What entry should you make under "marital status" for a man who obtained a divorce and is now remarried?

While the particular case quoted may be rare, it is common enough to find a respondent who has had more than one marital status since he first married and it is important for the enumerator to know that only the current status counts.

(2) Finding errors in completed questionnaires. Before the course begins, photographic reproductions are made of questionnaires which have been completed containing deliberate errors. These are distributed to the trainees who have to find the mistakes. The commonest mistakes in practice are omissions - answer spaces left blank. There should therefore be a number of these in the specimens. Entries made in the wrong place are also common. Where boxes are provided for alternative responses one sometimes finds more than one box marked. Contradictions between age and other data are common. Examples of all of these errors should be included in the specimens. Such tests are particularly useful in the training of supervisors since part of their job consists of checking completed questionnaires for errors; but they are also useful for the enumerator because they show him what kind of mistakes are likely and how to check his work. These two types of test, questions testing knowledge of the instructions and detection of errors in completed questionnaires, are both useful and test two different aspects of the enumerator's performance. Both should therefore be used.

In the case of a multi-round survey, it is a good plan to organize a refresher course before the second round. Particular attention should then be paid to the problems encountered at the first round and how to handle them.

In this section much space has been devoted to problems of instruction and written tests. However it must be stressed that the most important part of an enumerator's training is practice interviewing in the field. It is most important to check the enumerator's performance at this stage (i) by means of direct observation by a supervisor or other trainer or else by tape recording, and (ii) by careful scrutiny of the questionnaires completed.

Contents of the manual

In this section we give a suggested list of contents for the enumerator's instructional manual. This list has been put together from a number of existing manuals but does not exactly follow any of them. Any actual survey is likely to have special features and these will involve modifications and additions. Our suggested contents should therefore be regarded simply as a basic minimum.

Before giving the detailed contents of the manual something should be said about its presentation. It should never be forgotten that the enumerators do not share the same level of education as the author of the manual. Their knowledge of the language used in the manual (e.g. English or French) is likely to be limited and they probaby find reading difficult. The author should therefore make a conscious effort to write in a very simple way. He should use easy words, short sentences, short paragraphs. The text should be broken up by many headings: for a person who does not read easily, a large block of text is discouraging before he even starts to read it.

The lay-out and reproduction can help to make reading easy. Print size should be large and the space between lines should be generous (1 1/2 line spacing if typing is used). A popular rpresentation is to use two columns; the main text is on the right half (or two-thirds) of the page, with headings or summaries on the left. In some manuals pictures have even been introduced to help break up the text.

For the text to be easily understood, clear language is not enough; it must based on clear thinking. An example of an instruction which is both badly thought out and badly expressed is the following from an actual manual.1/

> "The basic unit of enumeration will be the homestead, or housing unit, which is usually, but not necessarily co-terminous with a household, or a group of persons living together in a homestead".

This is difficult to understand both because the word "co-terminous" is not widely known and because the logic is difficult to grasp, if not self-contradictory. Furthermore, any practical use the instruction may have is almost entirely cancelled by the words "usually, but not necessarily". This leaves the reader uncertain how to proceed when a difficult case arises. Definitions are worth including only in so far as they give the enumerator clear directives for dealing with doubtful cases. Note in this connexion that United Nations definitions, as presented in such documents as "Principles and Recommendations for the 1970 Population Censuses" are intended for use by survey and census planners; in most cases they are not suitable for use by field staff and they should not be transcribed word for word into the enumerator's manual.2/ The survey planner will have to work out for himself what form of words is most likely to persuade the enumerator to obtain the information which the United Nations definition requires. If a qualifying clause is so complex that it cannot be expressed in terms simple enough to be understood by every enumerator, it is better dropped.

1/ This example represents an isolated defect in an otherwise exceptionally well written manual.

2/ This statement becomes obvious when one considers the first sentence of the definition of "age", extracted from the above document. This reads: "Age is the estimated or calculate interval of time between the date of birth and the date of the census, expressed in completed solar years".

A real difficulty is to decide how much to put into the manual. Every additional page makes the manual look more difficult to the enumerator and reduces the chance of his absorbing each item. Before finalizing the manual the writer would be well advised to look at each page very critically and consider whether any of the material could be dropped. To take another example from real life: in one African manual the enumerator was told of the need to dress correctly. While dress is certainly important, it would seem best to bring this matter personally to the attention of any ill-dressed enumerators during the training course, instead of burdening all the enumerators with an instruction which most of them will not need. Clearly all this is a matter of balance: if too much is put into the manual, the important material will be buried in a mass of less important detail and will not get through to the reader.

The suggested list of contents follows.

[country] DEMOGRAPHIC SURVEY

ENUMERATOR'S MANUAL

List of Contents[1]

Chapter 1. The Survey Programme

1. Why are we conducting the survey?
2. Plan of operations (broad description of the survey)
3. Time-table
4. The survey organization (include personnel, transport).[2]

Chapter 2. Preliminary Work in the Sample Area

1. Documents and equipment which you will need
2. Contacting the chief, introducing the survey
3. Area map and description
4. Identifying your sample area
5. What to do if there are errors in the map or description
6. House numbering and listing
7. Making appointments
8. Working out your itinerary.

Chapter 3. How and Whom to Interview

1. What is a household? (if institutional population and homeless are to be covered, include section on these)
2. Fresh questionnaire in each household (main questionnaire only)
3. What to do if the household runs on to more than one questionnaire
4. Who should be interviewed in each household? (include: reference date, residence qualifications)
5. Call-backs
6. Lay-out of the questionnaire (and other forms, if any)
7. Order of filling in the questionnaire (and other forms, if any)
8. How to record the entries (include: how to delete a wrong entry; what to do when a question does not apply, e.g. fertility for male respondents; record responses directly on the questionnaire, not on a rough copy).

1/ Entries in parentheses would not actually appear in the section headings of the manual. They have been inserted to clarify the contents where necessary.

2/ A 5th section on administrative arrangements, including pay and conditions of employment of enumerators and discipline, may be added here or it may be preferred to distribute this information independently of the manual.

Chapter 4. Detailed Instructions on the Questions

(In this chapter the questionnaire items are taken one by one with instructions on the method of completing them. Reference to list of definitions in appendix - only the more important definitions appear in the present chapter).

Chapter 5. Checking the Completed Questionnaire

1. Checking that there are no blanks
2. Checking one question against another (details of all the main consistency checks).

Chapter 6. After Completion of Field Work

1. Summary of results (in many surveys the enumerator is asked to give a summary count of the persons enumerated, as the first step in the preparation of a rapid preliminary population estimate).
2. Return of documents and equipment (include list of items to be returned).

APPENDIX 1. Definitions

APPENDIX 2. Specimen Completed Questionnaire (include other forms, if any).

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Duration of training

The length of the training course is a matter in which survey practice has varied widely. Surveys in which a large number of enumerators have been taken on to work for a short time (around one month) have generally limited the training period to one week. At the other extreme, in some dual record projects the training has continued for 3 weeks, although the work which the enumerators are called upon to do is no more complex than the one-shot survey. Some kind of explanation for this difference can be seen: if enumerators are to work in the field for only a month, then to train them for nearly a month implies an extraordinarily high relative out-lay on training, whereas if they work for a year 3 weeks' training does not appear excessive in relation to total enumeration costs. However, this reasoning does not, obviously, justify the differences in survey practice. If 3 weeks of training really is necessary for the dual record then it is also necessary for the one-shot survey, and in that case the argument about the relative cost of training simply amounts to an argument against the one-shot survey on grounds of high cost.

Where such wide differences in expert opinion remain, it would be tendentious to express any strong recommendation in this manual. We suggest tentatively that a two-week training period might be considered as a norm. Persons with previous experience should need less training than inexperienced recruits; also less training is needed where field workers are organized in teams under experienced team leaders. One further important reservation must be noted: if any serious attempt is to be made to have enumerators use the historical calendar for age estimation then several days of coaching should be allocated for this alone. In practice this could add a week to the training course. Finally, in all multi-round surveys (including dual record systems) frequent refresher courses should be organized.

Note that the training of substitute enumerators is frequently skimped. They need exactly the same amount of training as the initial group of enumerators.

Training course: Summary

The enumerator's training course should be based on some such programme as the following:

(1) Lectures. These should follow closely the instructional manual. They begin with the general arrangements and become progressively more detailed. This part of the course could last from 2 to 3 days.

(2) Demonstration interviews. Interviews are conducted in front of the class by trainees. Responses are recorded against a large-scale replica of the questionnaire, using either a blackboard or a PVC sheet. Later, the method is modified so that each trainee records the responses on a questionnaire; these questionnaires are then checked for errors and returned. One day might be allowed for the interviews and one day for critique and discussion.

(3) Field work. Actual interviews are carried out by trainees. Questionnaires are checked and returned. As many interviews as possible should be observed by supervisory staff. A week should be reserved for this highly important part of the training, which should include critique and discussion.

(4) Tests. Tests should be given at various times during the course, after completion of Part 1. Two types of tests are suggested: questions testing knowledge of the instructions, and "find-the-mistakes" tests on deliberately faulty questionnaires.

(5) Refresher course. Before the second round in the event of a multi-round survey, and before subsequent rounds if needed.

(6) Substitute enumerators need the same training as the main body.

Training of supervisors

Almost the same course and methods are suitable for supervisors, but there are a number of additional points on which they require instructions: fuller information about the background and purpose of the survey, getting the support of chiefs and local authorities, the procedures for supervision, additional procedures for distribution and collection of documents, etc..

A common plan, which is recommended, is to train the supervisors for a few days immediately before the enumerators' course. They then attend the latter also, thus consolidating their knowledge besides helping in the organization of the course. It is also a good plan to use as supervisors in the main survey the people who did the field work for the pilot.

A supplementary manual for supervisors is often produced.

9.4 FIELD WORK: PRELIMINARIES

Mapping and reconnaissance

Almost any demographic survey in Africa will involve at least one stage of area sampling - that is, a sample of areas or small districts will be selected from a list or map. It is important to ensure that the area surveye is the same as the area selected. Any error in this respect may cause a bias (See Boundaries of area units in Section 7.1, where it was pointed out that the bias is likely to be more important where the survey is used to estimate totals, as opposed to rates, percentages or averages).

Where the area units are based on a demographic census they are generall identified by maps and/or descriptions, which are available centrally. Where they come from an administrative census or other administrative source they ar more often identifiable only as locality names whose boundaries can only be determined by consulting local knowledge. Note, however, that the place-name listed in an official list is sometimes intended by the central authorities to cover more than the unit known by that name at the local level. The only way of validating the list is to take it into the field and to make sure that every locality known locally is allocated to one place name in the list.

Once he has reached the area and cleared the survey with the chief or other relevant authority, the enumerator's first task is to identify the exac geographical coverage of his sample area. In particular he must determine which hamlets or outlying dwellings belong in the area. In surveys where a map of the area is issued to the enumerator he is expected to enter these details on the map; in surveys where he is not given a map he is usually requ red to make one - a very rough sketch-map suffices.

In the event of conflict between the map and the description issued to the enumerator, or between either and the reality which he finds, he is requi ed to report the matter to his supervisor. Such conflicts should be settled by referring to the maps or descriptions of neighbouring areas. The supervis should attempt to settle the issue in terms of the intention of the original map-maker or lister, not in terms of convenience for the present survey. The important consideration is to take the choice out of the hands of the enumera tor, in order to reduce the chance of a biased decision. It is not advisable to lay down as a general principle that where the map and description disagre the map should be accepted; on the contrary, it seems to be the case that descriptions tend to be more reliable.

In some surveys, the supervisor is required to undertake the reconnais-sance of the area units before the survey begins.

In general, the amount of effort spent on preliminary reconnaissance should depend on two questions:

(1) Whether the survey is required to produce estimates of totals, or only of rates, percentages and averages;

(2) How defective are the existing maps or descriptions or how ambiguous the locality lists. This can only be determined by some preliminary enquiries, including field checks, which should be made several months before the main field operations begin.

Publicity and approach to local authorities

In most African surveys, before field work can begin, the local or traditional authorities, as well as the population itself, have to be persuaded of the official backing of the survey and asked for their co-operation. There are several possible ways of doing this which are mentioned below. The choice depends much on local conditions and it would not be appropriate to recommend a particular method here; the decision is one for the survey organizer. It should be mentioned, however, that the need to obtain the support of the traditional authorities is a much more serious problem in some parts of Africa than others. Thus in some areas hours, or even days, of discussion and persuasion with the village chief may be unavoidable, while in others the District Commissioner only has to give the order and the chiefs at once fall into line.

In approaching officials at the higher levels, it may be useful to have the supervisor present a letter from the minister. For lower officials and even the general population a printed leaflet may be useful. In any case we have already noted that all field workers should be provided with an official card authorizing them to collect information for statistical purposes within the context of the survey, which should be specified as to title and approximate date on the card.

At the level of the village itself, it is often useful to call a public meeting, which may be addressed by the supervisor and the local chief.

Perhaps the commonest method of publicity has been an announcement over the radio. This seems to be very effective in convincing the public of the official backing for the enumerator's activity and securing co-operation. In urban areas a newspaper announcement can sometimes fulfil the same purpose.

Note that such pre-publicity needs to precede all field work, listing as well as enumeration.

All field workers, even drivers and guides, should be briefed about the survey as they may be called upon to answer questions by the local population.

House numbering and pre-listing

In many surveys the enumerator is required to number every dwelling in his area and to indicate this either by affixing a numbered sticker to the outside of the house or by painting a number on the wall or door.

Such numbering is essential in the following cases:

(1) Where a sample of dwellings or households is to be selected for the survey within the sample area. Note, however, that we have advised against such sampling in Chapter 7.

(2) Where there is to be more than one round of the survey in each household. The numbering then has to be applied at the first round and repaired if necessary at subsequent rounds.

In addition, the house numbering assists supervision. Since the number appears both on the house and on the questionnaire, the supervisor can quite easily find the house for any questionnaire he wishes to check. There is therefore a strong case for house numbering, although in practice many African surveys have not used it.

As to the method of numbering, stickers are less likely to be objected to by the householder than painted numbers. (If householders object even to stickers, a promise can be made to remove them after the survey). Stickers can sometimes be obtained with an adhesive back which is covered by a removable strip of plastic; these are very convenient for the enumerator. The sticker should be affixed as high up as possible to make it more difficult for children to deface. It should be in a standard location - e.g. near and to the left of the main entrance to the dwelling - so that it can be easily found by enumerators and supervisors who come later.

It is somestimes argued against stickers that they are too easily removed. An alternative, which is rather more convenient than painting, is to use "magic marker" felt-tipped pens. Each enumerator should be given two pens, one black and one white, with instructions to use whichever shows up against the background material (which should be wood wherever possible).

In many urban areas houses are already numbered. Such numbers have frequently been allocated in chronological order of construction of the buildings, so that they are in a chaotic order on the ground. In addition, they usually refer to units which are inconveniently large - sometimes to buildings containing a large number of households. Their use for the survey is inconvenient but may be necessary if the population will not accept stickers or other marks.

In many surveys, the numbering of houses has been made into a separate operation covering the whole enumerator's area; the enumerator is required to complete this before starting the main interview operation. Often such a preliminary house numbering operation is combined with a <u>prelisting</u> operation; here the enumerator fills a form showing the dwelling number and the name of the household head, with one line for each household. The preliminary tour of the area for house numbering (and listing, if any) will generally be made by the enumerator in company with the local chief.

One advantage of house numbering the whole area before starting the interviews themselves is the assistance this gives to the supervisor in checking. The supervisor can arrive in the area at any time during the period of the main interviewing (generally at least a week) and check that the enumerator has not overlooked any part of the area; without the prenumbering the supervisor would have to wait until the end of the interviewing before he could be sure of this. By that time the enumerator may have left the area (the supervisor cannot always be in every area unit on the last day of work).

The disadvantage of pre-numbering - and still more, of pre-listing - is the time it takes. When the population is very dispersed this may be prohibitive. Also in some cases the supervisor is in no position to check the enumerator's coverage of the correct area because both supervisor and enumerator have to rely on the directions of the local chief; where this is so, the advantage mentioned in the last paragraph disappears. Thus no general recommendation can be given for or against the preliminary round for house numbering or listing; a decision has to be taken after considering the local circumstances. Note, however, that even if a decision is taken against a special tour of the area for house numbering, it may still be desirable to have house numbering, the numbers being applied at the time of the interview.

As to pre-listing, the purpose is to assist checking and follow-up. Note that the name listed for each household head should be the full name, not just the surname, since in many African villages a large proportion of the households bear the same "surname". It is convenient to include in the pre-listing form a column for the number of persons in each household. This is completed only later, after the main interviews. This procedure checks that none of the listed dwellings have been omitted in the interviewing and at the same time provides a convenient document for summarizing the population count in the area. 1/ After completing the survey in the area, the enumerator (or supervisor) totals the number of persons in all households and this serves as the first step in producing a provisional rapid estimate of population. Even in a survey which does not include among its objectives the estimation of total population, it is still useful to have the survey population of each area as early as possible for checking purposes.

If the enumerator is required to number each house, it might be thought that he would need a strict definition of "house". In practice this problem does not merit very detailed attention since the house number is not used as a statistical unit but merely as an address to assist checking and follow-up.

Ensuring that a respondent will be present

In most areas and in most seasons it is not possible to rely on the head of the household being at home during the day time. In some parts of Africa a farmer's land holdings are grouped around his house; in this case he will not be far away and it will be a simple matter to call him in for the interview. In other areas the average rural householder is working many miles from his house and cannot be called back. On the other hand, in some areas the wife can give the necessary information and can usually be found at home. In other areas she can only be interviewed if the husband has given prior permission, while in yet others this is not possible and the husband himself has to be present.

All these factors have to be considered when planning the field work. If interviewing can only be done in the evenings, the enumerators' output will be greatly reduced. Various arrangements have been used in African surveys for ensuring the presence of an appropriate respondent during daylight hours.

1/ In the event that "comprehensive enumeration" is used (see Section 4.1) the "number of persons" should be divided into three colums: residents present, residents absent, visitors.

In some areas the village chief or headman will order the people to stay at home as required. Where the husband's permission is needed in order to interview the wife, it may be possible to arrange for him to give his permission at the time of the house numbering or pre-listing operations; alternatively the chief may obtain such permission on behalf of the enumerator.

In a few surveys enumerators have been instructed to make advance appointments for interviews but it is not clear whether this has worked well.

9.5 FIELD WORK: THE INTERVIEW

Whom to interview

It is widely accepted nowadays that interviews must be conducted by the canvasser method, i.e. enumerators must visit each household to obtain the information. Interviewing by assembly or by using intermediaries (such as the village chief) has been found inadequate. Nor can the respondent be asked to complete the form himself.

As far as possible each person should speak for himself. A wife is more likely to give accurate information about her own fertility history (particularly in respect of a previous marriage) than her husband. It is a mistake to suppose that children cannot answer for themselves. Any child who is going to school is likely to know his age and his school grade better than his parents.

In most cases, it will be found that the interview has to be conducted with the family as a group, and the head of the household may then give all the replies. It may be necessary to accept this, though it is far preferable to have each woman answer the questions about her own fertility. If the husband insists on giving the answers, at least the enumerator should try to ensure that each person concerned is present and can hear the replies given in respect of him so that he can correct any error.

Because of the importance of interviewing each individual, a common practice has been to add a colum to the questionnaire for indicating which persons were interviewed. The most frequent version of this technique has been to head the column "Seen/Not seen". This can cause confusion however: the person may have been "seen" without having been questioned or even without having been present at the interview. Another version is "Questioned/Not questioned" But a better method is to head the column "Who gave the information?", the answer to be entered in the form of the serial number of the person who responded, for each line of the questionnaire. Even this is not quite so simple as it appears, and to deal with doubtful cases it is best to allow the enumerator to make more than one entry in one line if the information was contributed by more than one person. It should be realized, however, that the additon of a column of this kind to the questionnaire really contributes very little to controlling the enumerator's performance. The enumerator knows what we want to see in this column and can complete the column accordingly, no matter what he does at the interview.

In Moslem areas, it is generally impossible for male enumerators to question female respondents. In Sudan and Egypt (and in most developed countries), female enumerators have sometimes been used but this practice is still uncommon in Africa.

It is not practicable to insist on a direct interview with every individual: there will always be some persons absent. A good rule would be that at least every adult male who is in the sample and who has not left the area should be personally interviewed and every woman whose husband allows it, and call-backs should be made as necessary to achieve this. However, in some areas insistence on this rule would reduce enumerators' output to an unacceptable level. In multi-round surveys it is sometimes necessary to obtain information from neighbours, headmen, etc. when a complete sample household moves out or dies. But such a source of information should be accepted only as a last resort.

What questions to ask

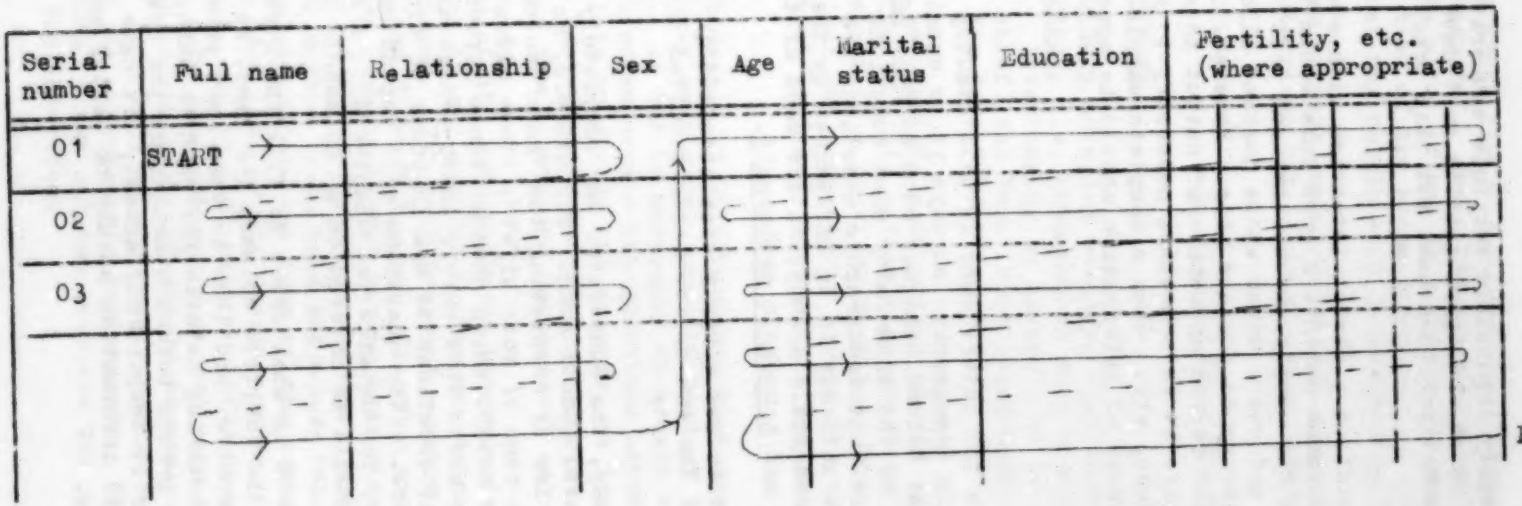
In social and opinion surveys the interviewer is told exactly what words to use in asking each question. In demographic surveys it is usually assumed that this is not necessary and that column headings such as Sex, Age, Marital status are sufficient to indicate to the enumerator what questions he should ask. The justification for this is that demographic questions are straightforward and factual, and therefore unlikely to be influenced by the form of words used. This is probably a reasonable assumption for most of the items, but there are two exceptions: age and household membership.

The problem of age determination has already been examined in Chapter 5. If the historical calendar is used the enumerator needs detailed instructions and coaching.

As regards household membership, the enumerator may completely overlook the need to establish this by careful questioning. For example, an uninstructed enumerator may begin the interview by completing the "Name" column, asking: "What is your name?"; "What is the name of your wife?"; "Your oldest child?"; "Your second child?"; etc. without establishing whether these persons are in fact members of the household. To avoid this error, instructions are necessary telling the enumerator exactly what questions to ask in order to find out who is to be listed in the questionnaire. (The questions will depend on whether enumeration is de facto or de jure; for details see Chapter 4). A real effort is needed to get all persons who should be covered on a household list.

The enumerator must also be told in what order to fill the questionnaire. Probably the best plan is to fill the complete columns for name, relationship and sex first, for all household members, and then to take each person on the list in order and obtain all the remaining details for each in turn, completing all the information for one person before starting on the next (see diagram on next page). If a member is temporarily absent, his name should be entered in the list but the detailed information should be left blank for completion at a call-back interview.

RECOMMENDED ORDER OF COMPLETION OF QUESTIONNAIRE



Note: A diagram of this kind could usefully be included in the enumerator's manual.

9.6 SUPERVISION

The supervisor has three main roles to fulfil:

(1) Administration. The supervisor distributes supplies to the enumerator and collects his completed work. In many cases he gives the enumerator his pay and arranges his transport.

(2) Supervision. The supervisor is the enumerator's immediate senior in the chain of command. He is responsible for introducing the enumerator to the area where he will work, for seeing that he in fact does the work, and for arranging for him to leave the area on completion. The enumerator refers to him any queries or unforeseen difficulties.

(3) Checking. The supervisor is ultimately responsible for the quality of the enumerator's work. This requires him to conduct a variety of checks, which are detailed below.

In many surveys the supervisors, although theoretically supposed to perform all these tasks, have been allowed to limit themselves to the administrative function only, namely (1) above. The importance of (2), and particularly (3), should therefore be specially emphasized during training.

Quality control of the enumerator's work

The following are the checking operations which supervisors can usefully perform:

(a) Check that the enumerator is present and working.

(b) Check that house numbers have been affixed, and in the proper place, to all dwellings within, and only within, the correct area.

(c) Check that the number of questionnaires so far completed corresponds to a reasonable speed of work.

The above three checks can be done fairly rapidly in the course of a visit to the area a few days after the start of the work.

(d) Check that interviews really were made for the questionnaires which have been completed.

(e) Check that the information recorded in the questionnaires is correct.

The above two checks can only be attempted in a sub-sample. Three or four households should be selected more or less at random and re-interviewed.

(f) Check the enumerator's interview techniques by observing him during a few interviews.

(g) Check the completed forms for omissions, inconsistencies and other errors.

The last check - (g) above - should cover all completed forms, not just a sub-sample.

A hard-working supervisor can complete this work in relation to one enumerator in one day if the area unit consists of a single locality. If the area unit is dispersed he may either have to omit outlying localities or stay two days. It is clear, however, that to be useful the check should not start until the enumerator has completed the house numbering (and pre-listing if any) and carried out at least one or two days' interviewing, while on the other hand if checking is left too late most of the work may be completed before the enumerator can be put on the right lines. Ideally, the supervisor should visit each enumerator's area for checking between about the 4th and 10th days of work. Assuming that the enumerators work in isolation in different areas and not as a team and assuming they all start work at the same time, this implies that the number of enumerators for each supervisor should not be more than about 5. (We assume that half a day must be allowed for the supervisor to travel from one enumerator's area to another).

In many surveys several of these checks have been omitted, but it seems certain that each one of them will contribute to improvement of the quality of the information collected. It is in any case crucially important that every enumerator's work be checked intensively at an early stage of the field work.

Note that the checking of completed forms - check (g) above - can be usefully started during the field work but cannot be completed until after the field work.

These activities of the supervisor must be covered by clear instructions in the supervisor's manual and training course. It is a good plan to draw up a simple report form for supervisory visits, to be completed by the supervisor at each visit. The following is a suggested sketch of such a form.

REPORT FORM FOR SUPERVISOR'S VISIT

Name of supervisor: _____

Code No. of area visited: _____

Name of enumerator: _____

Enumerator arrived in area unit - date: _____

House numbering / Pre-listing operation - dates: Start: _____ Finish: _____

Demographic interviewing started - date: _____

Present visit of supervisor - FROM (time and date): _____

TO (time and date): _____

Checks made	Result
1. Was enumerator found working?	_____
2. Were house-number stickers on every house?	_____
3. Does the enumerator have sufficient supplies on hand?	_____
4. Number of interviews completed so far:	_____
5. Number of interviews checked by supervisor by examining completed forms:	_____

Note: Supervisor must sign and date each form checked.

Comments on forms checked: _____

_____

_____

6. Interviews checked by reinterview: (Serial Nos.) _____

Note Supervisor must correct any wrong entries, sign and date each form re-interviewed.

Comments on these: _____

_____

_____

7. Enumerator's interviews watched by supervisor: (Ser. Nos.) _____

Note: Supervisor must sign and date each form.

Comments on interviews watched: _____

_____

_____

8. Any further comments: _____

_____

_____

It is useful to provide each enumerator with a log book in which each supervisor or field organizer who visits the enumerator must enter the date and time of each visit, with his signature. This enables the field organizers to check that supervisors are making the required visits.

As a further check that the supervisor is in fact doing his work it may be useful to include on the main questionnaire the following box to be completed by the supervisor:

SUPERVISOR'S CHECK	
Form checked in office ☐	Sig. of supervisor
Interview watched ☐	_____
Reinterviewed ☐	Date: _____

Obviously it is better to prevent mistakes occurring than to find them after they have occurred. Enumerators should therefore be informed that supervisors will be visiting their area from time to time and will be making detailed checks on their work, including reinterviewing some selected households.

Programming the supervisor's work

Before field work begins the supervisor should work out a provisional time-table of visits and this should be transmitted to his field organizer (though it may be better not to tell the enumerators exactly when to expect his visits).

The supervisor normally has an office at some central point. When he is not in the office it is important that a note should be left in the office giving his whereabouts. The field organizer will be visiting supervisors from time to time and must have access to the office, even in the supervisor's absence. The best solution is for the field organizer to have a duplicate key but failing this the key should be left with some responsible person who is always available, and the field organizer must know who this is. Normally, the field organizer should have visited every supervisor's office in his area before the survey started and these arrangements should be finalized during this visit.

Supervision by field organizers and senior staff

Even more important than supervision of the enumerators is supervision of the supervisors. This can only be done by the field organizers and senior staff, who should therefore be constantly in the field during the period of field work. Their visits not only help to maintain high morale; they are also crucially important in preventing the spread of serious mistakes before too much damage is done.

The field organizer needs to be professionally motivated. He should convey to the supervisor and enumerators the assurance that they form an important part of a significant enterprise - that someone really cares about the work they do and the difficulties they have to face. He should listen to the enumerators' complaints about the supervisor and the supervisor's complaints about the enumerators, and the complaints of both about the survey procedures (He should avoid, however, undermining the supervisor's authority). He may need to clarify instructions given in the manuals or to correct misunderstandings. He should not change any of the survey instructions on his own

initiative, but if he considers that a change is necessary he should communicate urgently with the survey director, who alone can authorize a modification.

All of the above applies equally to other senior staff in the field.

9.7 FIELD DOCUMENTS

Careful thought should be given at the planning stage to the various documents which will be required. We have already mentioned the following:

For the enumerator

Authorization card
Map and/or description of the area
Enumerator's manual
Pre-listing forms (if any)
Demographic questionnaires.

If the enumerator is to cover more than one area he may also need a timetable and itinerary.

For the supervisor

All of the above
Supervisor's manual
Report forms for supervisor's visit.

In most cases the supervisors will also require the following:

General map of the area
Control forms showing documents and supplies issued and returned
Pay sheets
Travel claims forms
Population summary form (showing results of the rapid population count for each area unit in the supervisor's district).

The above is a minimum list. In many surveys there will be additional forms for special purposes.

The list of documents and forms for the enumerators and supervisors should appear respectively in the enumerator's and supervisor's manuals.

The reproduction of large numbers of forms (particularly the main demographic questionnaire) may take a long time and this may be the most important bottleneck in organizing the survey. The numbers required and the method of reproduction should therefore be decided several months in advance and firm arrangements made with the printers or other reproduction unit.

9.8 COSTS

Any discussion of survey costs must begin by distinguishing between advance estimates of how much the survey is expected to cost, and the final statements of the expenditures actually incurred. Although they will have many features in common, there are also important differences. The primary object of the advance estimates is to know how much money will have to be raised before the survey can be carried out. Thus if it is necessary to obtain vehicles and other equipment, their full cost must be included in the estimates; on the conclusion of the survey, however, such vehicles and equipment will normally have a residual value wich may be shown as savings in the expenditure statements. No estimate can ever be completely correct: many important elements, such as the number of interviews which the enumerators can be expected to conduct in a day, must often be based on little more than informed guesses. The survey will therefore cost either more or less than was estimated; and since it is normally less troublesome to show savings than to have to ask for more money, the estimates are usually on the generous side. Even so, certain items are often over-spent. Processing, in particular, frequently takes longer, and hence costs more, than originally anticipated. It would thus be useful (but has rarely been the practice) to publish in the survey report fairly detailed comparisons between the initial estimates and actual expenditure.

Secondly, it is necessary to distinguish between the direct (or overt) costs of the survey, for which special financing is required, and the "hidden" costs which are absorbed by the recurrent budget of the national statistical office or other government department conducting the survey. Some estimates and expenditure statements only cover the overt costs; but it is also desirable, for various reasons, that the hidden costs should be assessed as fully and as accurately as possible. Thus if a government seeks external aid to finance the overt costs, the funding agency will almost always want to know what the "local contribution" is going to be. An increasing number of government statistical offices in Africa are building up teams of professional survey field workers who are permanently on their payroll and equipped with fleets of vehicles; many also are acquiring their own computers, or else the principal government computer is located within the statistical office. In these circumstances almost all of the costs of any demographic survey are going to be "hidden". It then becomes all the more important that these hidden costs should be evaluated, if only to enable the statistical office to determine how its resources are being allocated and to provide evidence should the ministry of finance seek to make cuts in the budget.

Thirdly, any analysis of costs, either in the form of advance estimates or of statements of actual expenditure, should show the breakdown not only by items and sub-items (such as "personal emoluments - field enumerators") but also by the different operational stages: how much was spent on the enemerators' wages for the pre-test, for the training period, for the main enumeration, for post-enumeration checks, etc.. When the survey is of the multi-round or dual system variety, it becomes all the more important to set out the operational stages in detail. In fact advance estimates can normally only be prepared realistically in this way, so that the required analysis, if not published, should normally be available at least in some working files.

Published expenditure statements, however, are very rarely shown in sufficient detail. Yet they can only be of value for the planning of future surveys if one can see precisely how the figures are made up: to be told that a given sum was spent on enumerators' wages is almost worthless unless one can also see how many enumerators were employed, for how long, and at what rate of pay.

It is not possible to draw up a model budget, since systems of payment and accounting procedures vary greatly from country to country. In particular, the variations in the size and nature of the allowances paid to field staff are almost infinite. However, the check list of items shown below may be found useful. The way in which the items are grouped under headings and sub-headings is of course largely arbitrary and they may be re-arranged as required. Many items of equipment, such as vehicles, office furniture, etc., will not have to be specially purchased for the survey; but then some charge for depreciation may reasonably be attributed to the survey.

Personal emoluments and allowances

Head office staff

Survey director
Professional officers
Clerks
Secretaries and typists
Messengers, watchmen and cleaners
Accounting staff (accountants, book-keepers, cashiers, auditors)

Field staff

Regional officers
Supervisors
Enumerators
Guides
Drivers

Processing staff

Computer manager
Programmers and systems analysts
Computer operators
Code and punch room supervisors
Key punch operators
Coding clerks

Transport and travelling

Vehicle (including bicycle) insurance; licensing
Vehicle running costs (fuel; maintenance and repairs)
Vehicle allowances (for staff using their own vehicles)
Public transport fares and vehicle hire
Camping equipment; first aid and medical supplies.

Processing

Punches and verifiers (purchase, rental, maintenance, or depreciation)
Computer time
Punch cards, paper tape
Magnetic tapes, discs
Computer paper

Printing, stationery, office equipment and running costs, miscellaneous

Questionnaires
Record sheets
Instructional manuals
Satchels and stationery for field staff
Maps and aerial photographs
Coding sheets and other stationery required by coding staff
Head office stationery
Photocopying
Printing of survey report
Rental of building
Office furniture (including shelvings for storage of survey forms, etc.
Typewriters
Desk calculators
Postage, telephone and telegraph charges
Electricity and water
Toilet requisites and cleaning materials

This list of items does not envisage a special cartographic operation (other than possibly the preparation of village sketch maps), and it is assumed that the maps and aerial photographs may be obtained from the survey department. If a more elaborate mapping operation is required, appropriate cost items, such as the emoluments and allowances for the surveyors and cartographers and the cost of survey equipment, must be added to the budget.

It is often convenient (and indeed advisable) to add, say, 10 per cent to the estimates for "contingencies", but some funding agencies will not accept this.

It must be emphasized that the above list is one of items only. As has been stressed above, in order to give a proper account of the cost of each item expenditures should be broken down to show the number of personnel (or equipment items) involved, the daily (or monthly) rates and the number of days (or months). They should also be shown separately against the differen operational stages of the survey. These stages are discussed further below in the section on the survey calendar. A possible classification by stages would be:

(a) Preparatory and pilot
(b) Recruitment and training
(c) Field work
(d) Data processing
(e) Report writing, printing and distribution.

As an example, under the heading "(c) Field work" one entry might read:

Enumerators' pay: 48 enum. x 3 months x 35 000 CFA monthly = 5 040 000 Fr CFA

9.9. PILOT SURVEY

Most African demographic surveys have been expensive operations. In terms of 1975 prices, $200 000 would certainly not be an unusually high figure. Before undertaking expenditures of this magnitude it is desirable to organize a trial run, or pilot survey, in order that any unforeseen difficulties may be brought to light before they have a chance to jeopardize the success of the main survey.

At the same time a pilot survey acts as a sort of training course for the middle and senior staff of the survey. The numerators for the pilot will generally be the supervisors for the main operation, and the supervisors for the pilot will be the future field organizers and the statisticians. In this way everyone gains useful experience. In particular, the pilot will show what are the main misunderstandings and mistakes in the enumeration work; the training manual and the questionnaire can then be modified to counter these.

A further important purpose of the pilot survey is to find out how many interviews one enumerator can conduct in one day. This may lead to a change in the plans for the survey. For example, if it is found that enumerators cannot work as fast as expected, then either the planned sample size must be reduced or the number of enumerators increased, with a consequent increase in costs. It follows that the survey plan should be regarded as provisional until completion of the pilot survey.

Other uses for pilot surveys which have been suggested include:

- Trying out different forms of the questionnaire
- Estimating variance between and within sampling units, with a view to improved sample design
- Testing the acceptability of the survey to the population
- Providing test material for coding, programming, matching, etc.

and numerous others.

The objectives of the pilot survey determine its timing and the type and size of the sample. For example, if the pilot is supposed to estimate the variance components between and within villages, then a properly designed probability sample will be required of very substantial size (probably calculation would show that the sample would have to be too large to be feasible for a pilot survey). Moreover, enough time would have to be allowed for data processing of the pilot before the stage when the sample design for the main survey had to be fixed; in practice this would mean conducting the pilot long in advance. Similarly, a very long time interval would be necessary if it were intended that the pilot should provide information on all aspects of a follow-up survey or a dual record project. Thus the objectives of the pilot survey should be carefully examined in very explicit terms before

planning the pilot operation and its timing. In long-drawn-out or continuous operations, such as some dual record enquiries, some of the purposes of the pilot might be better met by regarding the first few months of the operation as a trial period.

A typical minimal pilot which we would recommend as adequate in most cases would involve from 5 to 10 enumerators working for one week. These enumerators would be the future supervisors of the main survey - or at least the senior supervisors if the total number of supervisors is too large for this. The sample might be selected purposively in two different types of rural area and, if relevant, one urban area. There would be no formal data processing but the complete questionnaires would be carefully examined for errors and potential coding problems. Such a project would fulfil the main requirements, namely:

- Bringing to light unforeseen difficulties in field work and coding
- Providing experience for middle and senior personnel
- Providing an estimate of the number of interviews per day.

The results of such a pilot survey might lead to a revision of the sample size, the questionnaire and the enumerator's manual. It would therefore need to be conducted about 6 months before the main survey. At a later stage the pilot would provide test material for the coding, punching and computation programme.

It should be stressed, however, that this is a minimum programme. If time allows it would be better to put the pilot results through the whole data processing programme before finalizing the questionnaire. This would imply perhaps a further 3 months delay, or 9 months altogether between the pilot and the survey. In these circumstances there is a strong case for extending the gap again by a further 3 months so as to undertake the pilot exactly 12 months ahead of the survey; this arrangement, which is commonly used for censuses, enables the field operations to be tested under strictly comparable conditions. A decision between this and the "minimum pilot" described above must depend above all on the amount of pressure for early completion of the survey.

9.10 PLANNING THE SURVEY

This section serves as a summary of the chapter.

The drawing up of a survey plan must of course be one of the earliest stages of the preparations. We have left it to the end of this chapter because planning involves a consideration of all the different operations of the survey and it seemed convenient to discuss each of these before considering how to fit them together.

Planning has three aspects: (1) fixing the features of the survey, (2) listing the operations to be performed, and (3) drawing up a time-table.

We give below a check-list of the main decisions which have to be taken in fixing the features of the survey. Note, however, that these decisions should be preceded by a careful consideration of the objectives of the survey, leading to a rough and provisional list of tables required. Only when armed with this basic statement of requirements is one in a position to take the necessary decisions about the design of the survey.

Check-list of main features of the survey design

1. Type of operation: single round survey
   or multi-round follow-up survey
   or dual record system (PGE)

2. Geographical coverage

3. Duration

4. Timing: Dates of start and completion of field work.
   (Note: full-time table is later worked out from this).
   Intervals between rounds (if relevant)

5. Type of enumeration: Enumeration teams v. individual enumerators
   Mobile v. fixed enumerators

6. Basis of enumeration: De facto; de jure; both

7. Content of questionnaire

8. Main features of questionnaire presentation, including method of recording and coding

9. Method of reproduction of questionnaire and other documents

10. Sample size

11. Sample design: Nature of area-sampling units (EAs; villages; other)
    Stratification
    Method of selection
    Method of estimation

12. Objectives of pilot survey. Will the pilot require complete data processing before finalizing (a) the sample, (b) the questionnaire? Implications of this as regards timetable of pilot and main survey.

13. Main features of pilot: Size of sample
    Location
    Number of enumerators

14. Survey organization: Number of personnel at each level
    Source of recruitment
    Transportation

15. Training: Number and location of courses
Duration of each course

16. Publicity

17. List of forms required for field work

18. Data processing: Coding and editing, punching, programming, tabulation
At each of above stages: number of personnel
number of machines
duration of work
location

Software, hardware.

When the features of the survey have been fixed a cost estimate should be made - or if one has already been made it should be reviewed. The detailed staffing of the survey organization should also be decided, with the responsibilities of each senior officer.

The survey plan can now be set out in a more operational form by listing the operations which have to be carried out. Target dates can then be entered against the operations, working back from the date of the start of field work. The operations should then be re-arranged in strictly chronological order, giving a complete survey calendar. A specimen calendar of this kind is shown below, with explanatory notes.

Notes on specimen survey calendar

1. The calendar may appear confusing or illogical at some points. This is because at certain times two sequences of operations are proceeding simultaneously (for example, field preparations and drawing up drafts of documents); since the presentation in the calendar is strictly chronological, the two sequences appear jumbled together.

2. The time intervals between operations in the specimen calendar should not be taken as recommendations. In practice such intervals differ widely between different surveys.

3. The early stages of any survey are apt to be confused since finance and planning of the operations are mutually dependent. To obtain finance for the survey a precise cost estimate is needed; this depends on a plan for the survey; but the drawing up of a plan involves some work and this work itself requires financing, or at least assumes that finance has been obtained. As a result of this circular relationship the early stages are not easily described in a calendar form, and moreover the procedure varies widely in different surveys. In our own example it might be assumed that before the calendar begins there have already been preliminary discussions and a rough costing has been made and the expenditures approved, based on a provisional and very sketchy survey plan. The item "approval of plan..." against the date 28/2/75 then refers to approval of the more detailed plan and of any modifications to the original cost estimate which may have been found necessary. Probably such approval can be given by the head of the national statistical office.

4. The following assumptions regarding features of the survey may help to explain some of the items:

(i) A single-round survey is assumed, to be conducted over the shortest possible period (1 1/2 months in this case). This implies a large field force, organized under regional offices.

(ii) Timing is worked back from an initial decision to carry out field work between end October and mid-December 1975.

(iii) Supervisors are assumed to be drawn from permanent staff but enumerators are selected by open competition.

(iv) The main questionnaire is to be printed. All other working documents are to be reproduced by duplicating from stencils. It is assumed that printing is a bottleneck and long advance notice is required. Because printing of a questionnaire is a difficult operation it has been assumed that two proof readings will be necessary. There is probably time for a third. To allow for unforeseen delays, a week or more has been left free after the deadline for each printing or duplicating operation.

(v) It is assumed that adequate maps of all sample areas are available in principle form the census office, although copies will have to be made.

(vi) It is assumed that the computer print-outs can be used, either directly or with a minimum of editing, in the main report.

(vii) The more complex demographic inferences (projections, fitting of population models, adjustments to allow for response defect) are to appear in a special analytical report so that the main factual report may be published as soon as possible.

A specimen survey calendar

Discussion with other departments and specialists. Study of literature. Examination of maps (including some sample field-checks). Leading to ..... Fixing of objectives. Leading to ..... Provisional list of tables required	Dec. 74 – Jan. 75
Preparation of detailed plan of survey (survey features as above, including present list; cost plan; responsibilities of senior personnel)	Feb. 75
Approval of plan by relevant authorities including final approval of expenditure. Not later than	28/2/75
Firm commitment from printers for printing of main questionnaire (dates as below)	1/3/75

Senior and supervisory staff designated and survey organization set up	March 75
Work on drafts of questionnaire, manual and other documents	March - April 75
Finalize tabulation programme. Start work on systems design	April 75
Pilot survey	
Questionnaire, manual and other documents completed in manuscript.....	2/5/75
Questionnaire, manual and other documents reproduced (by duplicating from stencils)..	26/5/75
Training course	2/6/75 - 13/6/75
Field work	16/6/75 - 21/6/75
Study of results. Revision of plans if necessary	23/6/75 - 4/7/75
Reminder to printer: questionnaire printing to start 1 month from now	25/6/75
Selection of sample areas	7/7/75 - 11/7/75
Work begins on final draft of questionnaire	7/7/75
Work begins on final draft of manual	14/7/75
Maps of sample areas obtained and reproduced ...	14/7/75 - 31/7/75
Questionnaire sent to printers	25/7/75
Start work on computer programming	August 75
Regional offices organize reconnaissance of sample areas and set up local supervisors' offices	Aug. - Sept. 75
First proof of questionnaires corrected	22/8/75
Manual sent for typing and reproduction	25/8/75
Advertisements for enumerators appear locally ..	1/9/75
Second proofs of questionnaire corrected	5/9/75
Examination and selection of enumerators in regional offices	15/9/75 - 17/9/75
Other forms sent for typing and reproduction ...	22/9/75

Blank questionnaires, manuals and other forms delivered to survey office	26/9/75
Supervisors' training course	6/10/75 - 10/10/75
Enumerators' training courses (3 locations simultaneously)	13/10/75 - 25/10/75
Field work begins.....	29/10/75
Detailed preparation for data processing (administrative and technical). Includes trial runs of editing and coding	Dec. 75
Field work ends	13/12/75
Supervisors bring all documents to regional offices not later than	19/12/75
Regional officers bring all documents to headquarters not later than	31/12/75
Editing and coding	Jan. - March 76
Computer programming completed	Jan. - Feb. 76
Punching	Feb. - March 76
Computing	April 76
Preparation of main report	May - Aug. 76
Printing of main report: Top copy to printer Carbons to government depts.)	31/8/76
Printing completed ...	31/12/76
Preparation of analytical report	Sep. 76 - March 77
Printing of analytical report completed	Sep. 77

It must be stressed that this calendar is only a hypothetical example. It will certainly need modification in any particular case, not only as to the time intervals but also as to the items in the list. Moreover, certain items have been abbreviated for convenience of presentation in this manual (for example: "other forms" - these should in fact be listed).

It will be seen that planning starts about one year before the field work. The main publication appears about one year after completion of the field work, although the report is available for use within the government (in the form of carbon copies) 4 months before this.

The preparation of an action programme of this kind should be considered an absolute essential. Many African surveys have run into difficulties through insufficiently tight planning. It is strongly recommended that the plan be pinned up on the wall in the survey office and the operations checked off as they are completed. This procedure ensures that nothing is overlooked; moreover it creates an implied commitment and thereby produces a strong incentive to meet target dates. It also impresses visitors.

CHAPTER 10

TABULATION PROGRAMME, DATA PROCESSING AND REPORTING

Introduction

This chapter does not consist of a detailed and comprehensive review of all the stages and problems of data processing. Such a review would be beyond the scope of this manual, and would require a manual on its own. For those persons who require further details, we recommend the "Atlantida" and "New Florencia" series of manuals produced by the US Bureau of the Census and the US Agency for International Development.

Most government statistical offices in Africa contain data processing units with well-established procedures for coding, punching, the production of machine tabulations, etc.. It should therefore be superfluous for us to describe these routines in this manual. Furthermore, generalisations are difficult in view of the wide diversity of processing equipment available in different countries: while some African countries possess powerful computers with sophisticated ancillary hardware, others have no electronic or mechanical equipment whatever and are sometimes obliged to make the tabulations by hand. However the latter cases are becoming increasingly rare, and even if there is no computer in the country concerned, access can generally be obtained to one elsewhere. We have therefore assumed in this chapter that some sort of computer will be available for the processing of the demographic survey.

This chapter therefore consists largely of a series of seemingly disjointed points, most of which relate specifically to the processing of demographic surveys. Some of these points may seem too obvious to be worth noting, but the fact remains that they have by no means always been observed in practice, sometimes with dire consequences.

Tablultion programme

In Chapter 1 of this manual it was recommended that a provisional list of tabulations should be drawn up in the earliest stages of the design of the survey. Although such a list will of course be subject to subsequent modifications, the need to ensure that the objectives are embodied in the tabulation programme cannot be overstressed.

It is further recommended that the list of tabulations should be divided into two parts: those of first priority and those of second priority. The list of first priority tabulations should be kept as short and simple as possible, but it should comprise all the basic tabulations needed for attaining the fundamental objectives of the survey. If the designers of the survey cannot specify a short simple list of first priority tabulations, it generall indicates that the objectives have not been sufficiently clearly thought out.

Since the primary purposes of demographic surveys vary from country to country, it is not possible to specify the exact nature of the first priority list. Various possible objectives have been discussed in Chapter 1. Thus

if the determination of the geographical distribution of the population is among the primary objectives, high priority should be given to a tabulation of the population by province, region or district; or if the survey is being used as a check on the population census, a tabulation of the population in each PSU will be required.

But since most demographic surveys will include among their primary objectives the estimation of the age-sex distribution and of the levels and patterns of fertility, mortality and natural increase, and assuming the questions asked are similar to those suggested in the minimum list in Section 5.3, the following list of 12 tables for inclusion among the first priority tabulations is recommended. They provide all that is required for making the basic estimates at national level.

1. Population by sex and single years of age, with five-year sub-totals.

2. Population by sex, 5-year age groups and survival of parents (father alive, father dead, father NS; mother alive, mother dead, mother NS).

3. Women aged 15 years and over by 5-year age group and 5-year age group of husband.

4. Women aged 15 years and over by 5-year age group, with total children ever born, number living at home, number living elsewhere, and number dead.

5. Women aged 15 years and over by 5-year age groups and number of children ever born (0 ..... 9, 10+, NS).

6. Women aged 15 years and over by 5-year age groups, date of the most recent live birth (periods preceding the survey: 0-12 months; 13-24 months; 2-4 years; 5-9 years; 10+ years; preceding calendar year but month not stated; calendar year before that but month not stated; no births; births reported in life-time fertility but date of most recent birth not stated) and survival of the child.

7. Women bearing children during the preceding 12 months by 5-year age group and number of children ever born (1, 2, ... 9, 10+, NS)

8. Women bearing children during the preceding 12 months by 5-year age group and 5-year age group of husband.

9. Women bearing children during the preceding 24 months by 5-year age group and month of the birth.

10. Women "not stated" as to date of last birth by 5-year age group and number of children ever born (1, 2, ... 9, 10+, NS).

11. Deaths of members of the household during the preceding 12 months by sex, age group (0, 1, 2, 3, 4, 5-9, 10-14, ... 70-74, 75+, NS) and month of occurrence.

12. Births to household members during the preceding 12 months by sex and month of occurrence.

The second priority list should comprise all the more complex cross-tabulations for the investigation of such topics as fertility and mortality differentials, e.g. the cross-tabulation of the fertility and mortality data by tribe, education, employment, occupation, etc.. Here again the analyst should have in mind clear-cut questions which he is trying to answer, and in some cases it may even be helpful to set these questions down explicitly in writing. He should also constantly ask himself who will want this information and what the user will do with the data when he has got them. The indiscriminate cross-tabulation of everything against everything else will only result in a waste of time, effort and money and produce a huge pile of useless paper which nobody ever looks at.

When designing the tabulations, two main considerations should be borne in mind:

(a) the tabulation should provide the statistician with the data in the precise form which he needs for his analytical interpretation;

(b) the format of the tabulations should be such as will both facilitate their handling during the analysis and permit the publication of the tables by photo-offset from the tabulations.

The statistician can himself do much to ensure the fulfilment of these requirements. It has been a common practice to draw up table stubs showing the column and line headings. This undoubtedly helps the programmer to understand what the statistician wants, but beyond that its usefulness is limited. The format of the tabulation often has to be changed substantially before it can be fitted on to the computer. We therefore suggest that the statistician should go one step further and himself draw up the computer "spacing charts".

The statistician need have no knowledge of programming before designing the spacing charts. All he needs is to obtain the special forms from the computer people, and find out how many vertical and horizontal print positions can be fitted on each page. Most IBM computers have 132 horizontal print positions and can fit either 50 or 60 lines per page, though some of the smaller models are restricted to 120 horizontal print positions. Most ICL computers have 120 horizontal print positions, though some are adapted to accommodate 160. Within these limitations, the statistician may specify the lay-out of the columns and rows of the tabulations as he wishes, marking with an X the exact position of each figure. Some suggested spacing charts for the 12 tabulations recommended above are reproduced in Annex 1. They have been restricted to 120 print positions and 50 lines per page.

There are other advantages attached to the statistician's designing the spacing charts:

(i) He is often in a better position to do it than is the computer programmer, since the statistician can more easily predict the number of digits which are likely to be required in each column. His doing so will be an immense assistance to the programmer and enables the two of them to establish a close rapport at an early stage of the operations. But it should also be understood that the programmer should never make any changes in the spacing charts without the prior approval of the statistician.

(ii) It forces the statistician to clarify in his own mind the precise details of his requirements, and if he then does not get what he wants he will have nobody to blame but himself. It also brings home forcibly to him the dimensions of the tabulations he is asking for; otherwise he may well request massive cross-tabulations of several different characteristics without fully realizing the unmanageable sheaves of paper which would result.

Systems design and programming

These are large subjects beyond the scope of this manual, and there is little advice we can give except to urge that work on them should begin early - indeed as soon as the tabulations and codes have been drawn up. Every effort should be made to have all the programmes written, tested and debugged before the start of the field work. If, as happens all too frequently, no work is done on the programming until after the field work has been completed, unnecessary delays of several months may ensue.

One way of ensuring that the systems design and programming is done early is to insist that the pilot survey should be completely processed. Since any changes in the questionnaire and tabulation programme between the pilot and the survey proper are generally of a minor nature, only small modifications will be required in the programmes. Indeed there are other advantages in processing the pilot: unforeseen problems in the processing operations may be revealed, and it is often easier to gauge the success or failure of certain questions if the data are tabulated and the distributions can be examined for plausibility and consistency.

Before work on the programming can be started a decision must be made as to what computer language will be used, and whether resort can usefully be had to some survey or census "package". We are not in a position to offer advice on these points, and the decision must be made in the light of the skill and availability of the programmers and of the type of computer being used. We would like to observe, however, that the packages are not always the panaceas which they may appear to be at first sight: the work needed to adapt them to suit particular surveys and particular computers is often considerable, and they sometimes take up so much of the core storage of the computer that restrictions have to be imposed in other directions. We suggest that before any government statistical office commits itself to the use of a particular package, it should seek the opinion of some other independent organization which has had experience of its use.

Probably the best known census or survey package is that developed by the US Bureau of the Census and known as CENTS, which has been used successfully in several countries. Yet even CENTS has its limitations. According to information available at the time this manual is being prepared, it can only be used with IBM computers and then not with the IBM 360/20; furthermore it has only been adapted for the preparation of tabulations and cannot as yet be used for the other functions of a computer in survey processing - for the validation and correction of the data, or for sample raising and the computation of sampling errors. However, it is possible that these limitations may shortly be overcome.

Another important decision at this stage is the nature of the computer input. Once the data have been coded, a variety of methods may be used to transfer them on to magnetic tape: punch cards, paper tape, mark sensing, optical readers, key-to-tape or key-to-disc. To discuss the pros and cons of these different methods is beyond both the scope of this manual and the competence of the authors. The decision will in any case almost certainly be made in the light of local circumstances. At the time of the preparation of this manual the great majority of African countries are still using punch cards as the main medium of input. But it is also safe to predict that this method will before long come to be regarded as old-fashioned and inefficient.

Codes and card design

The codes and card design should be drawn up in consultation between the statistician and the programmer more or less at the same time as (or at least immediately after) the drafting of the tabulation programme. The programmer will determine any limitations which he may wish to impose on the nature of the codes in the light of the computer language which he intends to use. Thus some programmers may wish to restrict the codes to numeric values only, and to exclude the use of alpha-punches or "zone"-punches (i.e. the "X" and "Y", or "11" and "12" positions on the punch card). If, however, the programmer does not wish to impose restrictions of this type, alpha- and zone-punches can in some circumstances be very useful. Similarly if an optical reader is being used instead of punch cards, the use of certain letters as well as the ten digits is sometimes permissible.

In the case of certain types of optical reader, experience has shown that certain digits tend to be rejected or mis-read more frequently than others. For example when the 1971 census of Botswana was processed using an IBM 1287 Optical Reader, it was found that 4's and 8's tended to be rejected more frequently than other numbers. It would seem advisable therefore to avoid as far as possible using these numbers when drawing up the codes.

From the statistician's point of view, the range of codes should be designed to facilitate the production of the specified tabulations and to achieve the objectives for which the questions are being asked. Thus if the survey includes a question on occupation in the hope that the resultant data may be used for manpower planning, an occupational code of at least three digits should be used; but if the question on occupation is asked solely with a view to cross-tabulation against fertility a single-digit code may well suffice. Clearly there is no point in using a three-digit code for a characteristic if only the first digit is used for the tabulations.

Despite this it should of course be borne in mind that, in the light of the results shown by the first priority tabulations, more detailed analysis of certain characteristics is sometimes called for. It is frustrating then to find that such analysis cannot be carried out because it has been precluded by the nature of the codes.

Some compromise is clearly required which should be based first on a realistic assessment of what further tabulations are likely to be required and second on the amount of extra work, both for the coders and key punch operators, which would be involved if a more detailed code is used. Thus whereas in the case of occupation, as cited above, the use of a three-digit rather than a single digit code will greatly complicate the coder's task, in the case of date of last birth (discussed below) a longer code would in fact simplify his work. In general the likelihood of errors on the part of the coders is a more important consideration than the additional time and cost involved.

Coding may be done either on the questionnaires themselves or on a separate coding sheet. Coding on the questionnaires is generally both faster and more accurate; but conversely it is sometimes a more difficult document to punch from. The decision must be made largely in the light of the format of the questionnaire and the skills of both the coding clerks and key punch operators.

The most convincing case for the use of a separate coding sheet arises when an optical reader is being used rather than punch cards. In these circumstances the coding sheet must be carefully designed and printed in accordance with the specifications necessary for the optical reader, and the coding clerks must be taught to write the numbers in certain ways, otherwise the optical reader will not be able to recognize them - for example, if the loop of a 6 is not fully completed, the optical reader will reject it as unrecognizable. In these circumstances the coding clerks must be closely checked and supervised if the number of rejections is not to become unmanageable.

If the fertility and mortality questions are of the type suggested in the minimum list in Section 5.3, two points relating to the coding may be noted here:

(1) For the interpretation of data on survival of fathers, it is necessary to make an estimate of the mean age of fathers at the birth of their children. For this purpose it is desirable to code and punch the age of the husband against the data for the wife in order to facilitate the production of tabulation numbers 3 and 8 in the list shown above. This can of course only be done when the husband and wife are enumerated together in the same household.

(2) Since the primary purpose of the question on the date of the most recent live birth is to extract those women who have borne a child during the preceding 12 months, a simple single-digit code has sometimes been used for this question: viz. code 1 denotes women

whose last child was born during the last 12 months; code 2 denotes those born between 12 and 24 months ago, etc.. This procedure, however, has not always been successful. It has sometimes given rise to confusion and serious distortion of the data. It is safer, therefore, to code the year and month of the birth as reported, albeit that this involves the use of a 4-digit code. It also has the advantage of enabling tabulation No. 9 to be produced which should help to reveal whether the annual rates have been distorted by heaping on certain months.

Editing

The purpose of editing is to detect and correct errors. Detectable errors are of four main types: blanks, illegal codes (e.g. 8 may appear in the card column of sex where only 1 and 2 are admissible), entries which are highly implausible or impossible (e.g. a woman with 80 children) and entries which conflict with other information (e.g. a child with more years of schooling than his age). All of these can be detected by careful checking of the completed questionnaires, although in the case of conflicting data one usually cannot be sure which one of the conflicting entries contains the error. In addition, the presence of error, but not its location, can often be detected through statistical checks (for example, if less than five deaths are reported in one year for a given group of 1,000 persons there is almost certainly an error of omission). This type of plausibility check is important but is not covered in this section.

In most cases the only means by which an error can be corrected with certainty is by returning to reinterview the informant. Thus, obviously, the best place for editing is in the field: the enumerators should be trained to look for their own errors and to detect inconsistencies in the answers given by the respondents. Likewise the supervisors should check each completed questionnaire, and if necessary send the enumerators back to the households concerned. Once the questionnaires have been returned to the head office the difficulties of substituting truth for error are much greater: it may be possible to detect numerous errors, but the right correction must almost always be in doubt.

In these circumstances, and in view of the increasingly sophisticated use of computers for the validation of the data, it is now commonly maintained that manual editing in the office is becoming a waste of time and effort; such editing, it is said, can be performed more quickly and more efficiently by the computer. This contention clearly has much to recommend it. But it remains true that the coding clerks should be taught to look for errors and if necessary to draw them to the attention of the senior officers.

Thus it is not unknown for some fundamental misunderstanding of the survey requirements to occur at a high level, so that all the field staff working in a given area make the same mistakes. Likewise there is sometimes a general tendency in some areas for certain questions to be left unanswered, presumably because the enumerators feel that they are "too difficult" and shy at putting the questions at all. Or again, evidence sometimes comes to light in the office which suggests that the enumerators have not visited the households in

their areas at all, and have filled the questionnaires with fictitious data. In such circumstances there is only one correct procedure: to return the questionnaires to the field and do the enumeration over again. Obviously the sooner this can be done the better.

However, these exceptional cases aside, once the questionnaires have reached the office it is in most cases unprofitable to send them back to the field for correction of minor errors; the cost would simply be too high to justify the small gain in accuracy. In these circumstances two broad options are available:

(1) We can code the erroneous or missing data as "not stated".

(2) We can try to correct the errors or supply the missing data on the basis of whatever evidence is available. (This is generally termed "imputation".)

As a broad generalization one can say that Method (1) is a more reputable scientific procedure. If data are not available the reader has a right to know it: he may wish to take account of the number of "not stateds" in his analysis. Nevertheless it is generally accepted that where the number of omissions or errors is small it is reasonable to get rid of them by some sort of imputation, provided the number of responses so imputed for each question is recorded somewhere in the report.

How are missing values imputed? The simplest plan is to assume that the missing values are distributed like the observed values. If we are concerned with ratios or percentages, this assumption can be met by simply omitting the "not stateds" from both the numerator and the denominator. If absolute numbers are being estimated, then one can inflate the results by the ratio:

$$\frac{\text{stated + not stated}}{\text{stated}}$$

Ideally this inflation factor should be worked out and applied separately for sub-classes - the more disaggregated the better.

The corrections just described would be applied at a statistical level, that is, after the responses have been counted. The word "imputation" is generally reserved for methods in which each individual "not stated" response is replaced by an imputed one. This has certain advantages: once the imputation has been done the "not stated" categories - particularly cumbersome in 2- and 3-way tabulations - disappear altogether without the need for any further computations, and all percentages for any given sub-group refer to the same total. True imputation in this sense can be based either on assumptions such as the above (that the missing values are distributed like the observed values) or on fixed assignment rules designed to give the most plausible value in each case.

The use of fixed assignment rules is particularly appropriate for illegal codes and for inconsistent entries because in many such cases it is possible to infer with some confidence what response was intended (e.g. the entry "W" under sex no doubt means "woman" and should be "F"; if the number of children

living in the household is entered for one woman as "30" and if the household list shows just three of such children, the 30 can be changed to 3). Imputation by assuming that the "not stateds" distribute like the "stateds" has one disadvantage: one usually does not know what this distribution is until the processing is completed, so that the imputation cannot precede the main processing. (The obvious exception is the variable "sex" which we know in advance must distribute approximately 50-50. Omitted sex entries - always rare - have thus in some surveys been replaced by imputing male and female alternately). This difficulty has been met in some computer editing programmes by the "hot-deck" method: the missing or faulty entry is changed to agree with that of the previous person entered into the computer and whose other main characteristics are the same as the person under consideration.

In certain special cases one can say quite categorically that any imputation method should be avoided which is based on the assumption that the missing entries are distributed like the observed ones. Whenever the response takes the form of a number, and if zero is an allowable response, then a "not stated" is far more likely to be a zero than any other number. Examples are the number of children ever born and the number of years of schooling. In such cases the not stated group should be shown separately in the published tables, preferably with a note mentioning that they are likely to be made up almost entirely of zeros.

Once the questionnaires have reached the office, error detection (including missing entry detection) is best performed by a computer. Whether or not the errors are to be corrected by the computer, it is always advisable to print out all errors in a list and it is also convenient to print a count of the errors found on each question. If computer imputation is used, the list should show not only the erroneous entry but also the imputed entry. Nor should this list of corrections just be thrust aside by the statistician as an unwelcome document. He should give it close scrutiny and, if the corrections are too numerous or if there are many of one type, the matter should be investigated more closely, if necessary referring back to the original questionnaires.

If it is decided to use the hot-deck method, certain precautions should be taken:

(1) It should not be used for items such as those mentioned above in which a "not stated" is much more likely to be a zero.

(2) If large chunks of consecutive data are missing (for example, one enumerator may have consistently omitted age) the hot-deck method will repeatedly make the same correction, which is likely to introduce a bias. The error print-out should therefore be carefully studied to see whether there is a concentration of errors in any one area.

(3) As mentioned, the hot-deck method should always be accompanied by a count of the number of errors on each individual question. However, we lose the information on the cross tabulation against other variables. It is always possible that the error rate is very high for some sub-group. Precaution (2) above should detect this

in the case of a geographical sub-group, but it is also desirable (though unfortunately difficult) to scrutinize the error print-out for any concentration of errors in a particular group of the population.

On the whole, for a relatively inexperienced survey office working with a small or moderate sample, there is much to be said for confining the computer editing to error detection without error correction and for maintaining the not-stated categories through into the final tabulations. This will save some complex programming and avoid any risk of data loss through imputation.

Non-response

A more extreme case of the missing entry is the complete failure to get any information in respect of an individual or household known to fall within the sample. There are several distinct possibilities which we discuss in turn.

Individual not contacted. In African demographic surveys as usually organized this case will not normally lead to a "non-response"; we do not normally require the enumerator to interview each household member individually but rather to get the information from whomever is available for interview. Any missing information resulting from absence of a household member can be covered by the arrangements for "not stated" responses on individual questions.

Household not contacted or refusal. Both of these groups are generally rare in Africa. The number of such cases should be stated in the report (if there are none this should be stated), tabulated by reasons for non-interview and any available characteristics (at least the geographical location will always be available). Provided this is done and assuming that these cases are rare, an adequate treatment in the tables should be (1) to ignore the effect on percentages and rates and (2) to inflate any estimates of absolute numbers by the ratio:

$$\frac{\text{Households interviewed + households not interviewed}}{\text{Households interviewed}}$$

This correction should be applied, if practicable, by geographical areas.

Area missed. Part of a sample cluster (PSU) may be missed in error. In such a case it is highly desirable to send the enumerator back to complete his job. If this cannot be done the problem can be treated as the next case.

One or more PSUs missed. This is perhaps the only source of non-response in African surveys which is both important and rather common. It sometimes happens that one or more of the selected PSUs turns out to be inaccessible, for any of a variety of reasons ranging from floods to civil disturbance. Where this happens it is, again, highly desirable to attempt the enumeration nevertheless, if necessary at a later date. But if this is absolutely impossible we have two policies to choose from:

(a) We can adjust the data on the usual assumption that the non-response is like the response. This is best done by increasing the raising factor for the stratum containing the missing PSU; specifically, we multiply the data obtained from this stratum by the ratio number of PSUs selected to number of PSUs successfully surveyed, in the stratum concerned. 1/ An alternative correction which is generally less efficient but may be more convenient is to duplicate the data for one of the PSUs successfully surveyed in the stratum. (If only two PSUs were selected and one was missed, these two corrections amount to the same thing.) As usual, the fact that such adjustments have been made, and the number of PSUs affected, should be clearly stated in the report. The above is a reasonable strategy if only one or two PSUs are missing.

(b) If an appreciable number of PSUs have been missed one should consider the possibility of redefining the survey coverage. For example, suppose five selected PSUs have been missed and suppose that four of these were in the Eastern Province. We might then drop the Eastern Province altogether from the enquiry, explaining in the report that conditions made it impossible to cover the province and the data therefore relate to the whole country less the Eastern Province. The fifth missing PSU (not in the Eastern Province) might then be treated as (a) above. This approach makes the reasonable assumption that it is more useful to give representative data for a well-defined region than data of doubtful value for the whole country.

If the missing PSUs are both numerous and scattered, neither of these solutions will work and the only satisfactory answer is to find some way of going back into the field and covering the missing PSUs.

Before leaving the subject of omissions and non-response, it should be emphasized again that none of the methods of dealing with such errors actually replace the missing information. They are all essentially devices adopted for mere convenience because the presence of "not stated" columns in tables is a nuisance. For this reason, getting rid of the "not stateds" and non-responses, by whatever manipulation, without informing the reader or user amounts to dishonest presentation of data.

On the other hand, provided the user is kept informed, there is no objection in principle to such manipulations. The user will have to make some assumption about the not stated and non-responses if the survey people have not done it for him. Often the latter are better placed to do so by virtue of their familiarity with the data collection process.

Note on replacement. In some surveys arrangements are made to interview additional persons to replace non-respondents. There is not much point in this.

1/ If we are interested in estimating totals and if census data are available for PSUs, it would be worth replacing "number of PSUs" in the above by "census population of PSUs".

Replacement cannot eliminate the bias due to non-response. If we have the resources to interview such additional persons they should be added into the sample in any case, not as "replacements" but as additional sample material. If we have not, we can use the various forms of statistical "replacement" already discussed without doing any additional interviews. Replacement is no solution to non-response.

Preliminary sorting and hand counting

When the questionnaires are printed each one should have been numbered mechanically; or, if they are made up in books, these books should have been numbered and, if possible, each questionnaire numbered serially within the book. When the questionnaires or books are distributed to the field, a record should be maintained in the head office of the numbers issued to each district or enumeration team. Similarly, in the field the supervisors and enumerators should maintain records of the numbers of the questionnaires or books issued to each enumerator and used in each area.

On the completion of the field work, all questionnaires and books, whether they have been used, unused or spoilt, should be returned to the head office, together with the record sheets. Thus the first task of processing will be to check the questionnaires or books against the various records, and to ensure that all have been returned. If any are missing, the field workers should be asked to account for them.

It will then be necessary to separate the used from the unused and spoilt. This is a seemingly simple task, but it should be remembered that when one is dealing with large numbers of documents it is remarkably easy to make a mistake. It is essential, therefore, that the unused and spoilt should be checked before they are finally put aside and destroyed, in order to ensure that no used ones have been included among them in error.

Once the used questionnaires have been sorted out, a hand count should be made of the population enumerated in each area. In the case of a survey designed to estimate total population (or to adjust a census estimate) this hand count may form the basis of the provisional results, which are often published within a few weeks of the completion of the field work. In addition, hand count results serve as useful control figures for later stages of the processing. Although they will of course be subject to small margins of error, they can constitute a valuable safeguard against some of the more serious mistakes of processing described in this chapter.

Production of the tabulations

Whatever method is used for feeding data to the computer, the procedure is never immune to human errors on the part of the computer operators. Thus cases have been known of whole boxes of cards being put on to tape twice, or, conversely, of their not being put on at all. Such mistakes should not of course occur in well organized computer installations, but unfortunately there are all too many such installations, the world over, where the standards of efficiency are not all that they might be. It is possible to build checks into the systems design which will detect multiple entries of the same records; but omissions cannot so easily be forestalled.

For this reason, as soon as the data have been transferred to tape the computer should print out check totals of the population enumerated in each area. These totals should then immediately be compared with the hand counts made at the outset of the processing. Minor disparities due to errors in the hand count are of course to be expected but any major discrepancies must at once be investigated.

Turning to the tabulations themselves, these have been discussed in an earlier section but three further points deserve mention which relate to the presentation of the tables.

First, the format of the tabulations should be such as will facilitate their handling during the analysis. When calculating rates and ratios it is irritating if one continuously has to take the numerator from one tabulation and the denominator from another. Again cases have been known of the tabulations running on continuously from one page to another, the figures sometimes even being printed along the lines of the perforations. This has meant that the perforations could not be burst and the tabulations have had to be kept in one long string, making them awkward to handle. It also meant that they could not be fastened into covers or files, and the paper rapidly became torn and dirty. Again the statistician-consumer can do much to forestall such eventualities if he himself draws up the spacing charts.

Secondly, it should be remembered that it is often useful to be able to reproduce the tabulations by photo-offset to form tables in the published survey report. From this point of view a compact and elegant lay-out becomes doubly important. Another useful trick in this case is to write the tabulations to be photographed on to a special tape; a clean, evenly-printed table suitable for reproduction can then be produced from this tape. This procedure has obvious advantages, particularly as regards the subsequent saving of computer time if the original tabulation is found to be defective from the photographic point of view - e.g. the printing is too faint or smudges have been made.

An obvious requirement where tabulations are concerned is that the totals (of population, or of women aged 15 and over, or of women bearing children in the last 12 months, etc.) should agree between one tabulation and another. If one puts X records into the computer, X records should invariably come out. Yet in practice discrepancies are frequently found. Such discrepancies may be due to misinterpretation of the specifications by the programmer, or to programming or operational errors. But whatever the cause it is essential that they should be discovered and rectified as soon as possible. If the tabulations are just stacked away somewhere and nobody looks at them for several months, the chances of the errors being corrected satisfactorily will be minimal: the programmer will have left, or the data file will have been lost, or no computer time will be available for re-running the tabulations, etc.. Thus the first duty of the statistician when the tabulations come off the computer should be to check that the totals agree, and to draw the attention of the computer staff to any discrepancies. This cross-checking should be done not only between tabulations of different characteristics, but also to ensure that those for geographical sub-divisions add up to the national totals.

Figure 1

Uganda Population Census 1969

Rating up Sample Census for District 20

Africans

		Citizens					Non-Citizens				
	AGE Group	Rural General	Rural Sample	Total	Rating Factor	Urban	Rural General	Rural Sample	Total	Rating Factor	Urban
Males	00-04	38,712	4,402	43,114	9.7942	964	246	9	255	28.3333	52
Females	00-04	39,932	4,477	44,409	9.9194	1,046	233	10	243	24.3000	69
Males	05-09	33,386	3,816	37,202	9.7490	664	181	13	194	14.9231	37
Females	05-09	33,457	3,917	37,374	9.5415	819	168	6	174	29.0000	44
Males	10-14	25,843	2,958	28,801	9.7366	597	142	4	146	36.5000	34
Females	10-14	23,637	2,696	26,333	9.7674	568	96	6	102	17.0000	41
Males	15-19	16,810	1,921	18,731	9.7507	550	162	6	168	28.0000	42
Females	15-19	17,030	1,961	18,991	9.6843	614	124	5	129	25.8000	41
Males	20-24	13,627	1,505	15,132	10.0545	714	140	9	149	16.5556	63
Females	20-24	18,175	2,100	20,275	9.6548	773	104	6	110	18.3333	54
Males	25-29	14,508	1,735	16,243	9.3620	945	121	13	134	10.3077	78
Females	25-29	19,814	2,319	22,133	9.5442	743	102	10	112	11.2000	33
Males	30-34	14,318	1,600	15,918	9.9488	812	122	10	132	13.2000	66
Females	30-34	17,986	2,039	20,025	9.8210	470	68	9	77	8.5556	25
Males	35-39	14,482	1,571	16,053	10.2183	584	97	9	106	11.7778	57
Females	35-39	17,179	2,105	19,284	9.1610	345	58	5	63	12.6000	10
Males	40-44	12,232	1,465	13,697	9.3495	354	87	5	92	18.4000	27
Females	40-44	14,277	1,682	15,959	9.4881	190	46	4	50	12.5000	10
Males	45-49	11,913	1,396	13,309	9.5337	268	67	10	77	7.7000	27
Females	45-49	13,967	1,664	15,631	9.3936	138	27	2	29	14.5000	3
Males	50-54	10,349	1,242	11,591	9.3325	154	44	4	48	12.0000	11
Females	50-54	11,799	1,395	13,194	9.4581	104	22	2	24	12.0000	1
Males	55-59	9,457	1,092	10,549	9.6603	123	33	3	36	12.0000	5
Females	55-59	9,248	1,067	10,315	9.6673	42	15		15		2
Males	60-64	8,321	949	9,270	9.7682	89	23	1	24	24.0000	3
Females	60-64	7,313	772	8,085	10.4728	41	11	1	12	12.0000	1
Males	65-69	5,095	571	5,666	9.9229	48	12	2	14	7.0000	4
Females	65-69	4,423	492	4,915	9.9898	27	6	2	8	4.0000	
Males	70-74	3,233	374	3,607	9.6444	37	8	2	10	5.0000	2
Females	70-74	3,036	327	3,363	10.2844	15	5	1	6	6.0000	
Males	75+	4,758	516	5,274	10.2209	32	14	3	17	5.6667	3
Females	75+	3,607	469	4,076	8.6908	16	14		14		
Males	N.S.	270	106	376	3.5472	21	8	1	9	9.0000	
Females	N.S.	324	152	476	3.1316	18	6		6		
Males	Total	237,314	27,219	264,533	9.7187	6,956	1,507	104	1,611	15.4904	511
Females	Total	255,204	29,634	284,838	9.6119	5,979	1,105	69	1,174	17.0145	334

Sample raising

If the sample design is self-weighting and if no weights have been introduced to allow for failures of coverage and non-response, the rates, ratios and proportions can be taken straight from the survey without any weighting or raising. But in any other circumstances weights of some kind will be needed and in any case estimates of totals will always need raising.

The principles involved in weighting and raising have already been detailed in Chapter 8. Here we cover one further special problem which arises where a complex ratio estimate is used - as often happens in raising a built-in census sample.

If ratio estimation is to be used, a computer permits more extensive utilization of supplementary data than would be possible if the raising had to be done on desk calculators. For example, if the sample has been "built-in" to the national census it is possible to use separate raising factors for each sex-age group, etc.. For example, in the 1969 census of Uganda additional questions on fertility, mortality and other characteristics were asked in a built-in 10 per cent sample of rural areas; raising factors were computed for each cell in a four-dimensional matrix of race (five categories), citizenship (two categories: Uganda citizens and non-citizens), sex and five-year age groups. The method is illustrated by the "Work sheet" for the African population of Teso district shown in Figure 1.

This illustration, however, also demonstrates two of the pitfalls of this type of approach:

(1) Despite the fact that the raising factors were calculated to four places of decimals, small discrepancies with the complete census remained on account of rounding.

(2) Cases arose when there were no persons in the sample areas to fill some of the cells in the raising matrix; the raised sample figures would therefore fall short of the complete census totals by the number of persons in these cells enumerated in the complete census. Thus it will be observed that in the Teso figures there are no non-citizen females in the sample in the age groups 55-59, 75+ and "not stated".

These defects may be overcome in various ways.

Rounding errors may be eliminated by the use of the "integer" method of raising, which may be illustrated by the following example: in a given cell of the raising matrix 542 people are enumerated in the main census and 49 in the sample, giving a ratio of 11.0612; when raising the sample, 46 of the 49 persons are given a weight of 11 and the remaining three a weight of 12; thus $46 \times 11 + 3 \times 12 = 542$. The 46 here was computed from the expression $49 \times 12 - 542$, or alternatively $49 (1 - 0.0612)$. More generally, if we want to raise a cell from n cases in the sample to N cases in the census without using fractional weights, we divide the sample cell randomly into two groups of size a and $n-a$ and we split the raising factor N/n into an

integer I and a decimal d. Then we raise the a cases by I and the (n-a) cases by I+1. The value of a for this purpose is given by $n(I+1)-N$; or, what comes to the same, $n(1-d)$.

The problem of blank cells may be overcome by stipulating in advance that each cell in the raising matrix must contain not less than a specified minimum number of persons. If this requirement is not met, the cell should be amalgamated with a neighbouring one.

Sampling errors

The calculation of the sampling errors is a matter whose importance is too often under-estimated. The results of such caculations can be of value not only for assessing the accuracy of the data, but also for planning similar surveys elsewhere or at a later date. As computers become used more extensively for survey processing, it is to be hoped that more attention will be given to the sampling errors.

The computer operations involved in the computation of the sampling error may be divided into two categories. First there is the cumulation of certain basic figures from each sampling unit - the Σx^2 , Σy^2 and Σxy of formula (18) in Chapter 8. Second there are certain mathematical calculations to be performed using these cumulated figures. It is the cumulations which are the time-consuming part of the operation, and the subsequent calculations are performed relatively quickly. It is important, therefore, that the cumulations should be done at the same time as the compilation of the basic tabulations. This procedure clearly implies that the system'sdesign and programming of the sampling errors must be done well in advance so that the work can be spliced in with the production of the first-priority tabulations. If the whole subject is relegated to the status of second priority and no serious thought is given to it until after the first priority tables have been produced, all the original data tapes will have to be passed through the computer again to make the necessary cumulations, which is not only expensive in terms of computer time but greatly increases the risk that the whole operation will never be done at all.

Report

Obviously, the report is the individual creation of its author and this manual cannot say how it should be presented. Moreover, the centre-piece must be the results and their interpretation, a subject which goes beyond the terms of reference of this manual. However, it may be useful to present here a check-list of items for inclusion in the descriptive part of the report.

The list below has been grouped under headings for convenience but this does not necessarily mean that such a grouping would be used in the report. The tables and analysis are omitted from the list as well as the interpretation and conclusions.

CHECK LIST OF ITEMS FOR INCLUSION IN DESCRIPTIVE REPORT

A. GENERAL DESCRIPTION

Background

History of project and relation to earlier censuses and surveys

Reason for doing the survey now

Responsible organization (and, if appropriate, individuals)

Source of finance

Acknowledgements, if appropriate

Objectives

Broad statement of objectives

Detailed statement of topics on which information was sought

Have these objectives been fulfilled?

Description of survey

Single round or multi-round

Single or dual data collection system

Relationship to ongoing projects (census, survey ...?)

Geographical coverage

Time reference

A preliminary brief description of the sampling would be useful under this heading

B. DETAILED DESCRIPTION

Questionnaire

Copy of the questionnaire reproduced

Definitions of concepts[1/]

Any other special points not clear from the questionnaire itself

Time table

Dates of each activity

1/ It is often more convenient to have the definitions appear beside the data to which they refer.

Sample

Number of stages and nature of sampling unit at each stage (districts, EAs, households, etc.)

Sampling frame(s) used. Maps and mapping operations, if any

Stratification

Sampling fractions at each stage

Sample size at each stage

Method of sample selection - systematic or random

Defects in execution of sample design, including non-response, and steps taken to deal with these

Estimation. Include formulae used

Sampling error. Include formulae used

Any special analyses - e.g. analysis of variance between and within clusters

Field work[1/]

Publicity and other measures to win acceptance of the survey by the population

Training: method and duration

Number of field staff used, at each level, and source of recruitment

Duration of field work. Breakdown as follows is useful:

Average time per interview
Average time travelling between interviews in same cluster
Average total time spent in cluster
Average time travelling between clusters

Organization: teams or individual; transport; method of payment; method of recovering completed documents from field

Supervision

Quality control (field checks - statistical and individual)

Problems encountered - e.g. locating dwellings, finding people at home, eliciting accurate responses, language problems, etc..

Data processing

Systems design - flow chart

Editing and internal checks

1/ The enumerators' and supervisors' manuals are sometimes included in the publication. This is certainly useful to many readers and should be considered. If it is not practicable the manuals should be made available on request and this should be made clear in the report; and in any case the main definitions should appear in the report.

Coding - include speed of work and total time spent; show codes and card design

Input to machine

Tabulation

Details of any data available on request but not included in report

Costs

Detailed breakdown will assist planning of future surveys

External checks

Details of checks against independent sources of information. (Many of these will necessarily come in the sections on analysis and interpretation.)

No apology is made for presenting such a long list of items for inclusion in the report. A constant problem in developing countries has been the high turnover of specialized personnel, which has meant that the experience gained in statistical operations has been repeatedly lost instead of being passed on. The only safeguard against this is a policy of detailed reporting of work accomplished.

A common defect of survey and census reports is to exaggerate the success of the operations and play down the things that went wrong. In reality a report which gives details of the mistakes made is not only more useful to readers but also conveys a more impressive image of a modern and sophisticated approach to data collection. But above all, it is only through publication of detailed accounts of methods used and frank evaluation of their success or failure that a body of experience can accumulate, to the benefit of future workers in the same and other countries.

References

United Nations (New York) and The Food and Agriculture Organization of the United Nations (Rome):

Handbook on Data Processing Methods - Part I, 1959 - Part II, 1962.

The German Foundation for Developing Countries and the Federal Statistical Office of Germany:

Population Data and the Use of Computers, with Special Reference to Population Research, 1971.

U.S. Department of Commerce - Bureau of the Census:

Atlantida: A Case Study in Household Sample Surveys
Unit VII : Editing and Coding
Unit VIII: Tabulation Process

New Florencia: A Case Study for the 1970 Censuses of Population and Housing - Unit V: Data Processing.

CHAPTER 11

SOME SPECIAL TECHNIQUES OF DATA COLLECTION

This chapter gives fuller information about two special data collection techniques which have been widely used in developing countries: the multi-round follow-up survey and the dual record system (PGE). Both methods present a number of special problems which require separate discussion.

Both of these techniques have been the subject of considerable controversy. There are schools of thought which prefer one or the other and a third school which advocates single round surveys, besides a number of points of view which are intermediate or favour some other system. Clearly a manual is not the place in which to attempt to settle such a controversy. On the other hand it does not seem proper to ignore it. A section has therefore been added, after the description of each technique, giving a critique of the method; here the main objections which have been raised are listed, with the main counter-objections. Presumably, no enthusiast for any one of the systems will be quite satisfied with the presentation of these critiques. But at least this solution seems preferable to sweeping the controversy under the carpet.

11.1 THE MULTI-ROUND FOLLOW-UP SURVEY

Background

National surveys based on the follow-up principle have been conducted in Algeria, Lesotho, Morocco, Nigeria, Senegal and Tunisia, besides many countries in Asia and Latin America. There have also been several African surveys limited to one part of a country.

A long series of research studies was carried out in a limited area of Senegal during the 1960's under the direction of P. Cantrelle (ORSTOM), using repeat surveys based on the follow-up method. 1/ Many variations were tested and as a result a considerable body of experience was built up. Meanwhile on a wider scale the United Nations expert and inter-regional adviser in demographic statistics, V. Kannisto, was advising on applications of the same method in developing countries all over the world. This chapter owes much to the unrivalled experience of these two specialists.

Principle of the method

The multi-round follow-up survey is an attempt to overcome some of the sources of error inherent in the single round approach, as regards the estimation of births, deaths and migration. Basically, the idea is to carry out a first round in which the enumerator prepares a list of persons to be surveyed (selected as a probability sample) and then to visit the same sample after an

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1/ These pilot-type studies should not be confused with the Senegal National Demographic Survey of 1970-71, which also used the follow-up technique.

interval in order to record the changes that have occurred. Further visits may follow at appropriate intervals, so that the sample of households then becomes a sort of vital rate "panel".

The method should reduce both errors of omission and dating errors. An important limitation, however, is that it cannot cover all of the population at risk: two categories must be handled by retrospective questioning, of a type similar to that used in single round surveys, namely (i) persons who migrate in or out of the sample between rounds, and (ii) infants who are born after one round and die before the next.

A multi-round survey in which the same sample is interviewed repeatedly can be organized in three ways:

(1) There may be no link between the rounds, whether at the interview or in the processing. We then have a series of separate surveys, the only connexion being the common sample. This is sometimes called a "re-survey". It is not a true "follow-up".

(2) The interviewing may be carried out at each round without any reference to the rounds before (so that the interviewer does not carry with him the list of names made at the preceding round), but the processing may involve matching the lists from one round to the next in order to detect changes, and hence vital events. This is sometimes called "blind follow-up".

(3) The enumerator at one round works on the basis of the list made at the round before.

Only methods (2) and (3) can be called follow-ups. Their relative advantages will now be considered.

An enumerator who merely has to check off a list of people as present or absent, alive or dead, can produce plausible results without ever leaving home. Clearly, if the follow-up enumerator operates in complete ignorance of the data from the initial round this acts as an efficient check on his work. Unfortunately the problems of matching presented by this procedure are formidable. Almost everywhere in Africa addresses are non-existent or very inadequate, villages are common in which the same name appears again and again for different people, and one finds the same person giving different names (or the same names in a different order) to different enumerators. There is also the difficulty of making clear maps of villages, showing individual houses in such a way that they can be identified by another enumerator. In these circumstances it will be appreciated that a completely independent follow-up is scarcely a practical proposition. At the very least it appears necessary to give the follow-up enumerator a list of heads of households. This leads to a rigorous check on the composition of households, but not on the accuracy of the household list itself. This procedure was used in the 1961-63 survey of rural Morocco. However, the subsequent matching difficulties led to rejection of the follow-up as a source of useful data in over 10 per cent of the primary sampling units.

If the second round is carried out "blind" one cannot automatically assume that any person present at the first round who is not reported at the second has died, nor that any baby reported at the second round but not the first was born between the rounds. An essential component of such a blind follow-up will be a reconciliation round, in which a third visit is made to the field to determine whether each non-match represents a migration, a vital event, or an error.

In the light of problems such as these, the method of blind follow-up has generally been regarded as impracticable. The difficulties are certainly very great and it does not seem possible to recommend it. At the same time the alternative method, in which the enumerator merely has to check a list of names provided, obviously offers a strong temptation to the enumerator who is less than fully conscientious. This problem will be taken up again below.

Method of questioning

Various methods have been used for asking about births in a follow-up survey. Probably the one that has worked best is the following:

(1) At the first round: Ask each woman over 15 for her most recent live birth.

(2) At all later rounds: Ask her whether she has given birth to any child, whether living or dead, since the last birth recorded (referring to the latter by name if possible).

The household list itself then acts as a check. If a birth is mentioned, the enumerator must enter details of the child. If this is found to be a child already listed from the preceding round, the birth is outside the reference period. On the other hand a birth missed should be picked up ultimately (unless the child dies) when the enumerator asks at each round after reading out the list: "Are there any other people living here with you - any adults? ... any children?"

For deaths, the method is simpler. The enumerator reads the name of each person listed at the previous round and asks: "Is he/she still alive?" Except for certain special cases, a death can then only be missed if the respondent tells an outright falsehood. This is clearly a better method than the question used in single round surveys: "Has anyone in the household died in the last 12 months?"

Finally, whenever a birth is reported the enumerator asks: "Is the child still alive?" This covers deaths of children born since the preceding round. The question should also be asked at the first round in reference to the "most recent live birth" reported then - see (1) above.

The treatment of births and deaths to persons entering or leaving the sample area between rounds will be discussed later.

Ensuring conscientious field work

Undoubtedly the greatest danger to the success of a follow-up survey is the temptation it offers to the enumerator to skimp the field work by simply recording "no change". He can do this either by failing to visit the household, or by visiting it but skimping the questions.

Various safeguards have been used to limit this type of error.

If the survey continues for several rounds the results are virtually self-checking. A birth or death omitted at one round is unlikely to escape report for ever: as the rounds continue, sooner or later the new member of the household (birth) will be mentioned, or someone will draw attention to the wrongly included name (death or emigration). A useful precaution is to ensure rotation of enumerators so that the same enumerator does not stay with the same households. In this way the enumerators check each other. Moreover their knowledge that they are checking their predecessors and being checked by their successors keeps them up to the mark. A very simple way of achieving rotation of enumerators without any special organization is to allocate them at random at each round: if this is done it will hardly ever happen that an enumerator repeats a group of households in two consecutive rounds.

Another simple precaution to discourage enumerators from completely omitting the household visit is to include a new question in every round. As long as the answer cannot be guessed this provides the same degree of incentive to make the visit as applies in any ordinary survey.

Ensuring that the enumerator conducts the interview conscientiously is more difficult. A possible procedure (which does not seem to have been tried) would be to begin the follow-up interview not by reading out the list of persons recorded at the round before, but by asking for a fresh list of current household members (i.e. to begin with "blind follow-up"). The enumerator records these - name, sex and relationship to head - on a separate sheet before looking at the list of the previous round. He then compares the two and uses this comparison as a basis for further questioning, if necessary, to enable him to complete the questionnaire itself. The sheet recording the preliminary "blind listing" must be returned to headquarters; this will tend to discourage the enumerator from skimping the questioning. However, it could be objected that this system will annoy the respondents, who will not understand its purpose.

Another ingenious idea was used in the Indian National Sample Survey in 1958-59: false, or dummy, names were inserted into the list sent back to the field for the follow-up enumerator. However, this was found to be resented by the enumerators and indeed may do more harm than good. If the enumerator is informed in advance that dummies are present he loses confidence in the reliability of the list and his probing is likely to become overhasty: anyone not quickly identified he may write off as a dummy. If he is not informed in advance, then errors may be detected but they will not be avoided; moreover there will be many fruitless discussions which will no doubt lead in some cases to a mistaken "identification" of the dummy. On the whole the method does not seem to be one to recommend.

None of the above procedures ensure that the question on babies who were born and died since the previous round is conscientiously asked. The best precaution against the omission of this item is to record current pregnancies at each round and include a column for reporting the outcome: "Still pregnant"; "Birth, still alive"; "Birth, died later"; "Still-birth". There has been reluctance to use the question on current pregnancy in some African countries on the grounds that it causes embarrassment, or because it is said that the mother-to-be will fear to "tempt providence" by anticipating the birth. Attitudes of this kind vary much from one ethnic group to another. There are many surveys on record in which the question has been asked without apparent difficulty, and often against the advice of local experts. Indeed, there is a general rule of survey practice, supported by experience in countries all over the world, to the effect that "sensitive" questions which are expected to cause embarrassment generally prove more acceptable than anticipated. While one cannot, of course, rely on this, the pregnancy question is well worth testing in a pilot survey. (In most African populations, if the question is working, roughly one woman in four in the age-range 20-30 should report herself pregnant.) If asking the question is considered impossible, a compromise solution is to have the enumerator record visible pregnancies; the success of this as a check will depend, among other things, on the time interval between rounds. Note however that, even if the check fails in the sense that many pregnancies are missed, it can still fulfil its main purpose, which is to provide an estimate of infant mortality. Thus, if we follow-up all pregnancies reported we can determine the rate of infant mortality among these and use this as an estimate of the rate among all births. This seems likely to underestimate true infant mortality somewhat (those who report their pregnancy to the enumerator are more likely to report to the maternity services, with a consequent improved prognosis) but the bias seems likely to be small unless maternity services are very well developed. In any case, the method can easily be tried at the analysis stage and the results used if it gives a significantly higher rate than the direct estimate from the whole sample.

While the various techniques mentioned above are likely to be helpful, high quality results depend above all on high quality field work and this cannot be ensured by any combination of special devices of the kind described. Rather it depends on the general conditions of the survey, and in particular on:

(i) Good training. Enumerators must know what they have to do.

(ii) High morale. They must wish to do what they know they have to do.

(iii) Close supervision. They must be informed as soon as possible when they make mistakes.

Conditions (ii) and (iii) are particularly favoured by the team-working method of enumeration in which a group of four or five enumerators live together with a supervisor. We may also recall here the recommendation made in Chapter 9: supervisors should be required to repeat a subsample of interviews as a check. This leads to more conscientious work by enumerators, especially

if they are in permanent employment. 1/ Some specialists have also suggested that such checks should be run by an independent group of field workers on a properly selected subsample, allowing computation of a correction factor. This is essentially the "dual record" system, to be discussed in the second half of this chapter.

Frequency of rounds

The more closely spaced are the rounds the fewer will be the follow-up failures due to infant deaths and to movement in and out of the area. But this is not the only factor. Closer spacing of the rounds means a smaller number of events to record at each round. With a 3-month interval the enumerator must expect to have to record less than one event (birth or death) in every 10 households. Experience with surveys in many countries has shown that if the response to a question nearly always goes the same way it is difficult to get interviewers to perform reliably. 2/ There is also, of course, the factor of cost: the more frequent the rounds the greater the cost for a given sample of person-months. Thus, as regards the time interval between rounds there are arguments to be considered on both sides.

Experience in a number of countries seems to suggest that a period of one year between rounds is too long. Six months is probably the most commonly used interval. In urban areas, where mobility tends to be very high, visits every three months may be necessary. 3/ However, in rural surveys the three-month interval has usually been rejected by survey planners, both on grounds of expense and because of the strain it imposes on the survey organization.

1/ Note however that it has also been argued that such re-interviewing may annoy respondents and convey an impression that the enumerators are not trusted by their own organization.

2/ Two kinds of bias have been observed. (1) The enumerator sees that one response is much more common and so begins to assume that response without asking the question. (2) When a response comes that is nearly the unusual response (e.g. death of a person who was not strictly a household member but could almost be classified as one) the enumerator stretches the definition a little in order to be able to include this among the rare category. These two biases work in opposite directions.

3/ Relatively little experience is available on follow-up surveys in urban areas. Two African studies have been reported: Abidjan, 1963 (two rounds, separated by one year); and Yaounde, 1964-65 (two rounds separated by six months). In both cases it was reported that the extremely high mobility created serious problems at the data-processing stage.

Duration of the survey

Most multi-round surveys have continued for a year. There is no theoretical objection to spreading the work over a longer period - except that for a given total expenditure the data will take longer to become available. Indeed there is a considerable advantage in a long time-coverage since short term fluctuations in the vital rates will be smoothed out. There is also more chance of learning from mistakes and improving the methods, clearing up misunderstandings, debugging the procedures and replacing incompetent personnel. 1/

The possibility of spreading the survey over a period of years raises the question whether a fresh sample should then be selected each year. It would appear preferable to stay with a fixed sample, however long the period, at least until the population shows signs of resisting the survey. Repetition of the sample is not likely to lead to a loss of sampling efficiency, while on the other hand, if the follow-up concept is to be retained, any time the sample is changed there will be the additional cost of a complete round for the new base-line survey.

A total survey period shorter than one year should be avoided, in view of the need to eliminate seasonal variations.

Sampling

The sampling problem for multi-round surveys is essentially no different from that for single round retrospective surveys. However, the arguments in favour of complete coverage of each area sampling unit, rather than household sampling, are even stronger in the case of the follow-up survey. In such a survey the households selected in the sample have to be identified clearly at one round for the benefit of the enumerators who are going to carry out later rounds. If there is any sampling of households, or even of dwellings, this will cause much difficulty owing to the high mobility of the population and lack of addresses in most African areas. The only satisfactory basis for defining the sample is an area basis. The enumerator can then be told: "Interview all households within the given area".

As regards the optimal size of clusters, the argument presented in Chapter 7, Section 7.1 still applies with only minor modifications. The overhead cost per cluster appears at first sight to be somewhat reduced in a follow-up survey, because the preliminary reconnaissance of the area and the clearance with the traditional authorities will not need to be repeated after the first round. But this is to some degree compensated by the need to ensure identical coverage on two different occasions, which implies more care in mapping the clusters and defining their boundaries and hence higher initial expenditure. In a follow-up survey with a total duration of one

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1/ There seems to be no good reason why multi-round surveys have in practice been limited to one year in nearly all cases whereas dual record systems have generally continued for several years. The arguments for and against the long duration apply to both methods.

year it would seem reasonable to regard these effects as roughly cancelling and to continue to accept as optimal a cluster size of a few hundred persons. However, the longer the period for which each cluster is used in the survey the more the first effect would tend to predominate and the more the optimum would then tend to shift towards smaller clusters. In a follow-up survey planned for a long duration, therefore, it is desirable to make an independent attempt to calculate the optimal cluster size by estimating costs and following the methods shown in Annex 2.

Questionnaire design

Except in surveys where only a very small number of questions are asked, there are almost always difficulties in designing a convenient questionnaire for a follow-up survey.

At each round after the first, the enumerator has to refer back to the names listed at previous rounds; he may also need to refer to characteristics such as "relationship to head of household" for greater certainty in identification. He therefore has to take this information with him into the field and the easiest way of arranging this is to give him back the questionnaire completed in the earlier round and to have him insert the new data on it. In other words, one would like to use a single questionnaire for all rounds.

But this raises two difficulties. Firstly, unless the number of items of information is very small the format becomes inconveniently wide or else the document runs onto two pages. With a two-page questionnaire it is more difficult for the enumerator to refer back and for the supervisor and editor to check; there may also be inconvenience in data processing if this begins with transcription onto an intermediate form.

A second difficulty is that one would like to get ahead with the data processing as soon as the first round questionnaires come into the office, but if they have to go out again for the second round this may interrupt the processing.

A possible solution to both problems is to retain the original completed questionnaires in the office and copy out the essential information onto the questionnaire blank which the enumerator is going to take with him - essentially name, relationship, age, and date and name of last birth. This has the added advantage of safeguarding against loss. On the other hand such copying amounts to a considerable load of work. In some cases it may be worth doing for the first round but not for later rounds.

A solution to the second problem is to code the data onto coding sheets during the period when the questionnaires are in the office. In some surveys coding onto coding sheets is used in any case - notably where an optical reader is to be used - so that there is (arguably) no additional work involved in applying this solution. However, where optical reading is not used, coding straight onto the questionnaire is generally preferable because errors are fewer and checking is easier, so that this solution is less than ideal.

The alternative of photocopying may become competitive in price in coming years and this should be examined; but before this solution is adopted it is important to check (i) that a standby machine is available in case of breakdown, (ii) that the machine will accept the format planned for the questionnaire, and (iii) that an adequate supply of paper is available.

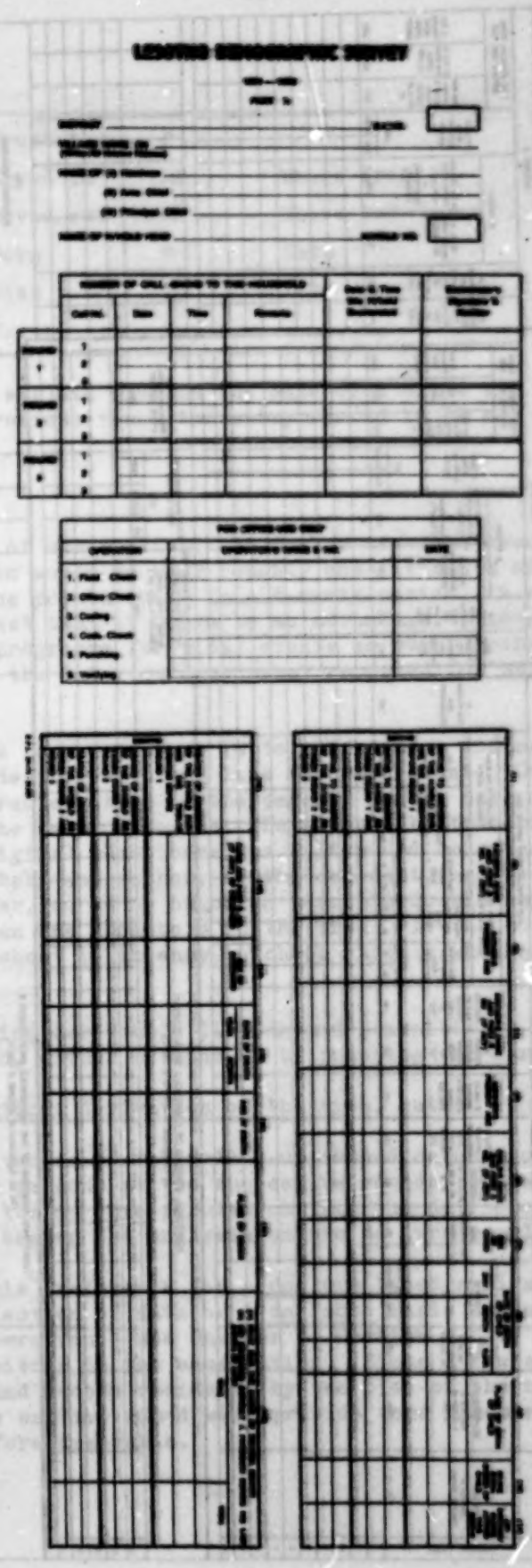
The problem of how to squeeze all the information on to one questionnaire, and preferably one sheet, was ingeniously solved in the Senegal research programme by the use of an individual questionnaire - one sheet per person, with each round's observations on a new line. Of course this implies many more sheets in all, with a consequent risk of greater confusion if anything goes wrong. It will also be somewhat more difficult to check the consistency of the individual characteristics with the household composition. A minor advantage is that the procedure to be followed when someone moves from one household to another in the same area is simpler - one just pulls out the person's questionnaire and puts it with the new household. If individual questionnaires are used it seems desirable to keep the sheets for a given household within a double-sized folded sheet which should carry information on household location and a list of the household members. The individual questionnaire seems to have been used only in the special research programme in Senegal, which was conducted under rather unusual conditions with intensive supervision. More experience would be needed before it could be firmly recommended for use on a full-scale national survey. Nevertheless it would seem to be worth serious consideration if the number of questions, or the number of rounds, is so large that a household questionnaire would be unwieldy.

It will be seen from the above discussion that the design of the questionnaire and the procedures for handling, copying, transcribing and coding are all interlinked and need specially careful thought in a follow-up survey.

A copy of the questionnaire for the Lesotho Demographic Survey of 1971-72 is reproduced herewith. This consisted of a single sheet 67 cms x 30 cms (26 ins x 12 ins). The main table, Part B, was a centre-page spread, with Parts A and C on the back.

This type of questionnaire has been widely recommended but less widely used. Its obvious disadvantage is that it is large and cumbersome. However the alternatives, as we have seen, are arguably no better: they are (i) to run on to two pages (as in the Senegal national survey), (ii) to use as individual questionnaire (as in the Senegal research programme), or (iii) to cut the number of questions to an absolute minimum (as in the great majority of other follow-up surveys in the developing world).

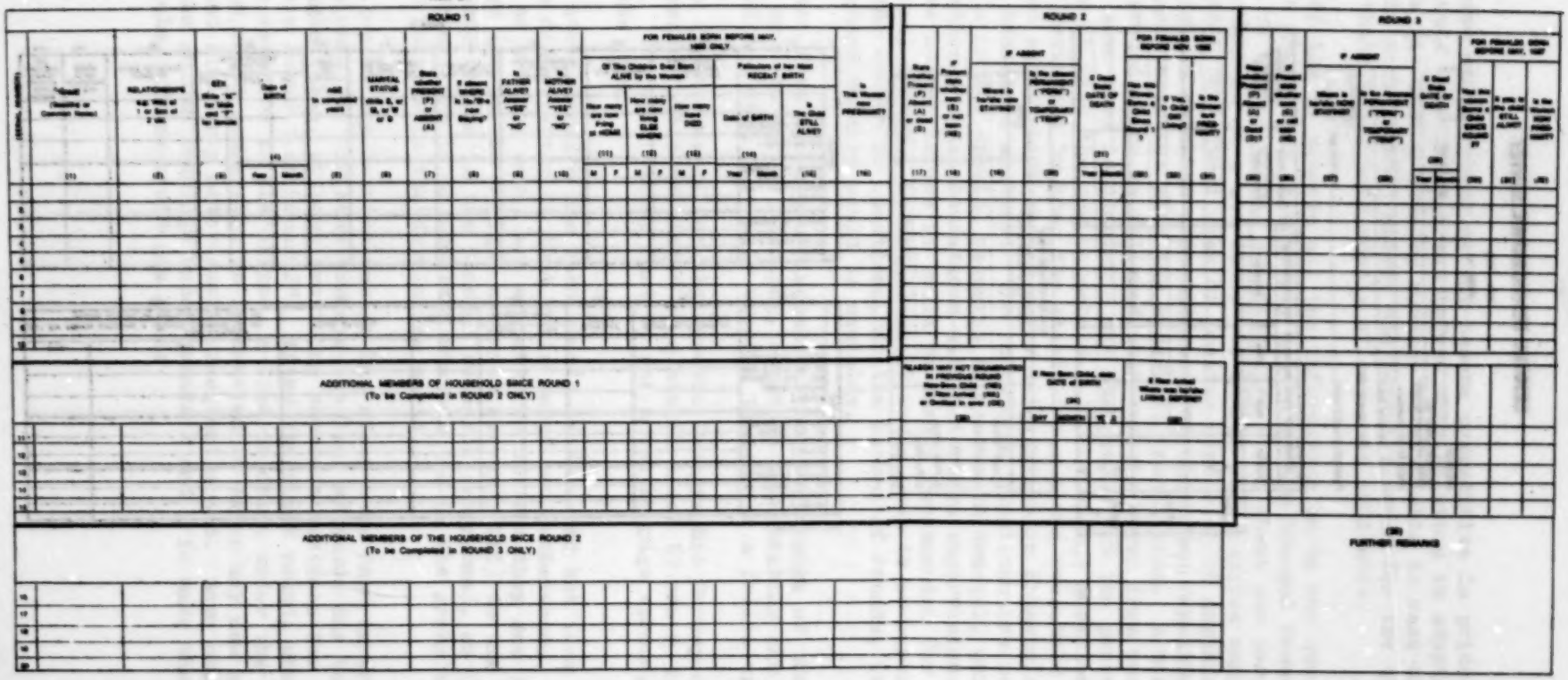
One modification to the Lesotho design has often been used in order to simplify the questionnaire. In many surveys the list of names has been presented in a single table, without providing separate sections for "additional members since Round 1 or Round 2". After the first round, when the questionnaires are returned to the office, a line is drawn under the last name and the second round enumerator is instructed to enter any new arrivals below the line - and similarly after each subsequent round. Some changes are then required in the column headings under Rounds 2 and 3 to make them applicable to new arrivals. These could now read:



LESOTHO DEMOGRAPHIC SURVEY

LESOTHO DEMOGRAPHIC SURVEY: 1971/72

PART B


ROUND 1
ROUND 2
ROUND 3
ADDITIONAL MEMBERS OF HOUSEHOLD SINCE ROUND 1
(To be Completed in ROUND 2 ONLY)
ADDITIONAL MEMBERS OF THE HOUSEHOLD SINCE ROUND 2
(To be Completed in ROUND 3 ONLY)
FURTHER REMARKS

Present	P	
Moved in	MI	Where from?
Moved out	MO	Where to?
Born	B	Date
Died	D	Date
Error	E	

The instructions explain that in the case of a child who was born and has died since the previous round the entry should be BD and two dates should be given.

Data processing

In one year of observation, the number of vital events recorded in an African population would be very roughly one-fifteenth of the number of individuals in the population. In a 6-month period, it would be one-thirtieth. These facts suggest that it would be an advantage to adopt an independent data processing programme for vital events as such, rather than to add them on at the end of the data (card or tape) recorded for each individual in the survey.

Probably the best procedure is to introduce a coding sheet for births and another for deaths, with one line for each event. Columns would be provided for characteristics of the parents in the case of births and of the dead person in the case of deaths. Data would be transcribed or coded by hand from the original questionnaires. It would be an advantage to enter the name of the baby and mother, or the decedent, and to complete the sheets cluster by cluster, so as to check on possible double reporting of the same event in more than one household in the area. If the population of the area is shown on the sheet it is easy to check rapidly whether plausible data are being obtained.

After checking for double listing and plausibility, such a sheet can be readily processed, either by hand or by punching one card per line.

Basis of enumeration; derivation of the vital rates

The effectiveness of the follow-up method depends on the enumerator finding the same persons at two successive rounds. Clearly this will happen more often with the de jure population than the de facto. Thus there is a strong case for basing the analysis on the de jure population.

However, this preference for a de jure based analysis does not necessarily exclude the collection of data on a de facto basis as well as de jure ("comprehensive" enumeration - see Chapter 4, Section 4.1). This would involve the inclusion of visitors in the enumeration. Since a few such "visitors" will have stayed on and become residents by the time of the next round, their inclusion at the earlier round will provide more cases successfully followed up and is therefore desirable.

In several follow-up surveys it has been found that the second and later rounds show a consistently larger population than the first. This has usually been attributed to the failure at the first round to record some household members, perhaps due to the inexperience of the enumerator or perhaps to suspicion by the household. But the effect may also be due to overlong retention on the household list of persons who have moved away; this could affect the second and later rounds more than the first if there were a reluctance to eliminate names once listed. To clarify this situation it seems desirable to use comprehensive (de facto and de jure) enumeration with a supplementary question "Since when ..?" Thus:

Resident present / Visitor	Since when has this person been here?
Resident absent	Since when has this person been away?

The qualifying period for residence can then be fixed as the period between rounds. (A baby's residence will be considered as that of its mother for this purpose).

Turning now to the enumeration of vital events, assuming that the analysis is to be based on a de jure population we have, in theory, a choice between three methods for counting the events between two consecutive rounds (say Rounds 1 and 2):

(i) Events occurring in the period to the de jure population of Round 1;

(ii) Events occurring in the period to the de jure population of Round 2;

(iii) Events occurring to persons who are members of the de jure population at the time of the event.

For births, we would prefer to get the information from people whom we can interview after the event: this favours method (ii). For deaths, method (ii) would be meaningless (a member of the Round 2 population cannot have died before Round 2). The main advantage of the follow-up method as regards deaths is that it enables us to pin-point a named individual and ask whether he is still living, instead of asking the vague, and upsetting, question: "Has anyone died?" This argument favours method (i). Thus it has often been recommended to use method (i) for deaths and method (ii) for births, adding to (i) the deaths of babies whose birth is reported in (ii), and adding to (ii) any births to mothers whose death is reported in (i). The slight inconsistency of reference between births and deaths is of little consequence. However, method (iii) is somewhat simpler in conception and has been widely used. Its only disadvantage it that it requires an additional question to the hosuehold: "Have there been any other deaths?", in order to pick up deaths to in-migrants,

after their arrival. 1/ Whichever method is used it is important to ask, of each birth reported, whether the baby is still living.

While definitions are important for the statistician, they are not sufficient as guides to the enumerator. Whichever system of enumeration is adopted it is important to give the enumerator specific instructions on how to deal with the more common types of borderline cases. In most African societies the commonest problem of this kind is that of the mother who moves to another house (usually her mother's) to have a baby. Note that this problem may be encountered at either end of the journey: we may be interviewing the household from which the pregnant woman moved away, or the household into which the daughter came to have her baby. Also we may conduct the interview during the period of the woman's absence from home, or after her return. From the enumerator's point of view these are four distinct cases. Other important cases are the woman who has a baby in hospital, the person who goes to hospital with an illness and dies there, and more generally the person who dies while temporarily away from home - for example, from an accident while visiting the town. The survey statistician, having decided upon the definitions for enumeration, should work out what these mean in terms of the above special cases. The enumerator should then be instructed exactly how to deal with each one of these possible cases. It is not sufficient to give the enumerator a broad definition and expect him to work out for himself how it applies to such borderline cases.

Adjustment to the reference period

In most surveys it is not possible to organize the time interval between rounds according to an exact schedule to the nearest day. An adjustment is therefore required to bring the rates to the equivalent of an exact 365-day period. This may be done by computing the mean date of the starting round, averaged over all sample households, the mean date of the finishing round, differencing the two to give the mean period, then raising by the ratio 365 to this mean.

Adjustment to age

A problem arises with age in any multi-round survey when we wish to compute age-specific rates, since different persons have their age recorded at different times during the survey. The majority have their age recorded at the first round, but those who appear for the first time at a later round will give their age as of that round.

The simplest solution is to have the enumerator record the date (or year) of birth rather than age. At the analysis stage the entry can then be translated into age at the date corresponding to the mid-point of the reference period. Note that this may involve a half-year deviation in the ages

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1/ Arguably, this could be omitted as negligible. For example, if we assume 6-monthly rounds, a 10 per cent annual migration rate and a 20 per 1000 crude death rate uncorrelated with migration, the 20 will be estimated as 19.5 if this question is omitted. (Even if included it is hardly likely to catch all the missing 0.5).

as tabulated, arising from the fact that "age last birthday" runs half a year behind chronological age. (A group of persons whose "age last birthday" is 30 will have a mean age of 30 1/2.) Thus, for example, persons born in 1945 will, in the middle of 1975, have a mean age last birth of 29 1/2, not 30. This situation will arise whenever (a) date of birth is given in completed years only 1/ and (b) the reference date for the survey is other than the start of a calendar year. It can be handled by a footnote in the published tables.

For infant mortality, however, it is important to obtain age at death to the nearest month, preferably up to 2 years at least, in order to eliminate heaping at 1 year. Instructions should therefore be given to enter date of birth to the nearest month for all children under 2, and in particular, of course, for all those born during the period of the survey.

Critique of the multi-round follow-up survey

Firstly, there is the question of cost. This turns out to be a more complex issue than it first appears. Obviously for a sample of given size the multi-round follow-up survey is much more expensive than the single round survey. This in itself, however, is not an over-riding objection: a bicycle made of cardboard would be cheaper than one made of steel, but no one uses this as an argument against the use of steel for bicycle frames. The cost must be considered in relation to efficiency. If it can be shown that the multi-round survey is subject to a smaller unknown error than the single round survey, then the extra cost must be accepted. More precisely, the criterion of choice should be, in principle, that of minimum mean square error per unit of cost. If b is the bias and σ the sampling standard deviation (see Chapter 8 for definitions), then the mean square error - or the total expected error - is $MSE = \sqrt{(b^2 + \sigma^2)}$. The method which gives the lowest value of MSE per unit of cost is the most efficient. Unfortunately this criterion, though helpful as a guide to thinking cannot be applied operationally, because b, the bias, is always unknown: if it were known we could subtract it from the survey estimate, giving an improved estimate with bias zero. In practice we can perhaps make a little headway if we replace b by a somewhat vaguely conceived standard deviation σ_b representing the spread of the distribution of uncertainty in the survey results due to non-sampling error. Such a σ_b is perhaps easier to guess than b itself. We can then compute $MSE = \sqrt{(\sigma_b^2 + \sigma^2)}$ and choose the method giving minimum MSE per unit of cost. But in reality no one has yet produced any serious estimates of b or σ_b for any actual single round or multi-round surveys.

1/ Age in completed years is the same as age last birthday.

In summary, the arguments about cost, though clear in theory, are of little practical relevance because we cannot estimate the biases. 1/

A more straightforward objection is the complexity of the follow-up method. Not only are there several rounds instead of one but there are additional operations: dwellings have to be clearly identified so that they can be found again, questionnaires have to be copied (or else removed from headquarters, with risk of loss and certainty of delay in processing). The instructions are necessarily more complex, requiring longer training of enumerators. The questionnaire itself has to be complex, or alternatively must omit some of the questions which would be desirable.

The long duration of the survey makes for difficulties: for example, it may rule out the possibility of using school teachers as enumerators; it requires arrangements to be made for regular payment of enumerators in the field; it involves a delay in publication.

There is also a difficulty in organizing an effective pilot survey, since an interval of several months must elapse between rounds if enough events are to be found.

The most serious objection to the method, however, as we have seen, is the danger of enumerators reporting "no change" without serious interviewing. We have suggested a number of ways of discouraging this but it remains true that the method is crucially dependent on the use of conscientious and highly motivated field workers.

Finally an objection of a sort is that the method is conceptually incomplete: the follow-up cannot in principle cover events to migrants or babies who are born and die between the same two rounds. Special arrangements have to be made to cover these categories by retrospective questioning. While

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1/ We can, however, show the following:

- If $\sigma = a/\sqrt{n}$, where a is a constant which is the same for single round and multi-round surveys and n is the sample size,
- If cost is proportional to n within either type of survey,
- If cost per unit of the sample is k times as high in the multi-round survey,

then the single round survey will be competitive in terms of the criterion we have stated if its bias b is less than $\sigma\sqrt{(k-1)}$, where σ is the sampling error for the single round survey. Since σ increases with diminishing n, and hence with diminishing cost, whereas b is constant or decreasing, it follows that if we consider the effect of progressively reducing the available budget there must always come a point at which the single round method becomes competitive. If b can be estimated this point can be calculated. It may, however come at a point where total error is unacceptably high. Conversely, if the multi-round method has a uniformly smaller bias than the single round and the budget is progressively increased there must come a point at which the multi-round method is competitive, although this may be at a budget level which is unacceptably high.

the latter is certainly an inconvenience it would not be correct to assert that a fol ow-up survey must show increasing bias due to the progressive attrition of the sample ("panel effect"), since the panel is in fact brought up to date at each round.

Apart from the claim to greater precision, two arguments should be mentioned in favour of the method. (a) It allows information to be obtained on migration which can come in no other way, specifically by the interviewing of emigrants before they move. (An analogous but minor advantage is that it gives us the age of a dead person as stated by him before he dies.) (b) It seems to give a better estimate of the total population: as noted above, the second and later rounds habitually reveal the existence of persons omitted at the first round. Finally it may be noted that the follow-up procedures after the first round represent a very light burden for enumerators. In this sense the follow-up survey is an ideal vehicle for other quite different types of enquiry.

11.2 THE DUAL RECORD SYSTEM (PGE)

Background

The dual record system is based on a simple concept: if two independent data collection operations are set up to cover the same sample, then one of them should pick up some of the events missed by the other.

While in principle the two operations may be of any kind, nearly all of the applications up to now have been with a periodic survey as one and a vital registration operation as the other, and we shall assume this arrangement in the rest of this section. In most of the more successful projects the "registration" has not been the official civil registration but a special vital rate registration set up for the purpose of the project. 1/

The technique is often called the "PGE", following the first large-scale application in the Population Growth Estimation project in Pakistan. Since then it has been used in many countries: if one counts only those operations conducted on a national basis or in a large fraction of the country, in Africa the method has been applied in Algeria, Liberia, Malawi and Morocco. Historically most of the "PGEs" have been set up as self-contained projects with some degree of autonomy and relying heavily on foreign assistance - the important exception to the latter being the Indian Sample Registration scheme which is also by far the largest of all the dual record projects. Moreover the projects, unlike the single and multi-round demographic surveys which have been carried out in developing countries, have been conceived from the beginning as continuing systems rather than as ad hoc operations, and most of them have indeed lasted for several years. Altogether, the dual record system has benefited from an input of high-level expertise, and an output of descriptive and analytical publications, far in excess of the multi-round follow-up

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1/ The registrars used in the project are for this reason often called "recorders" to distinguish them from the regular civil registrars.

method. Much of the digested experience of all this work is being published in a handbook prepared by the Population Council which should be considered compulsory reading for anyone planning to set up a dual record project. For this reason the treatment of the subject in the present section will be confined to a brief description of the essential features of the system and of the special problems which it raises.

Description of the method

Obviously if two independent data collection operations are set up to cover the same area, most of the events they collect will be the same; in relatively few cases will one operation detect an event missed by the other. We clearly need to know which events are the same in order to avoid double counting. Thus an essential feature of the dual system method is a matching operation: the events reported by one operation are matched against those reported by the other, producing a table of the form shown below.

		REPORTED BY REGISTRATION		
		Yes	No	Total
REPORTED BY SURVEY	Yes	a	b	
	No	c	d	
	Total			N

The matching gives us a, b and c. Only d remains unknown: the number of events missed by both operations.

It is usual to estimate d by assuming that the errors of the two operations occur independently. This implies that the rate of missing by the registration is the same in the top line as in the bottom line, or $b/a = d/c$, giving $d = bc/a$. Thus the total number of events is estimated as:

$$N = a + b + c + \frac{bc}{a}$$

This is generally referred to as the Chandrasekar-Deming formula, after the authors who first proposed it. 1/ It is in fact no more than an application of the method habitually used for estimating non-response bias in surveys, based on the assumption that characteristics of non-respondents have the same mutual relationship as those of respondents. Note that the estimate $d = bc/a$ is unbiassed only if the omissions by the two systems occur independently.

1/ Chandrasekar, C. and Deming, W.E. (1949), "A Method of Estimating Birth and Death Rates and the Extent of Registration", Journal of the American Statistical Association, 44, 101-115.

The problem of maintaining the independence of the two operations is crucial and in practice has dominated the design of dual record projects, leading to numerous complications. For example, but for this problem the matching could be performed virtually without error by the co-operative effort of the two field workers in the field; instead of this, to avoid the danger of loss of independence, matching is always done in the office without the co-operation of the field workers.

Loss of independence can occur in two ways: through collusion between the registrar and the survey enumerator, and through the existence of common features causing omission in both operations. We discuss these separately.

Collusion. If the survey enumerator and the registrar get together and agree to report the same events, or if one of them obtains and uses the reports made by the other, then not only is the Chandrasekar-Deming estimate falsified but the whole dual set-up becomes a waste of effort and money. Thus precautions are always taken to keep the two workers apart and to place a variety of obstacles in the way of their copying from each other's records. In practice these precautions complicate the procedures considerably.

Shared causes of omission. Events of certain types may have a greater risk of omission by both registrars and survey enumerators - for example, deaths of single-person households. Such a correlation between the operations would vitiate the Chandrasekar-Deming estimate of the fourth cell d. If such special features can be identified in the reports the effect can be eliminated by dividing the data into strata, each such stratum corresponding to one such type or feature, then applying the estimation formula separately within each stratum and summing the d's so obtained. This was originally recommended by Chandrasekar and Deming and has been done in most of the dual record projects. However, the results have almost invariably been unchanged by this correction; one must conclude that either such shared causes of omission do not exist or, if they do, they have not been successfully identified. It is easy to imagine that such unidentified features might still exist : for example, any events for which people feel guilty or embarrassed might systematically tend to escape report, yet such events might have no observable feature which would enable them (when they are reported) to be singled out as a class. There is also the danger that a respondent may withhold a report from the second field worker simply because he failed to report it (for whatever reason) to the first.

The Chandrasekar-Deming estimate makes another important assumption. It will be seen that when the registration and the survey disagree (cells b and c) we always accept the positive report and reject the negative one, that is, we accept the word of the man who found an event against the word of the one who did not. This is implicit in the inclusion of b and c in the estimation formula. The assumption here is that the only errors are errors of omission, never of erroneous inclusion. Errors of inclusion are referred to, in the jargon of the dual record technique, as "out of scope" events. They may be out of scope in space (i.e. outside the boundaries of the area sample units) or in time (i.e. outside the reference period). Such errors are not eliminated by the formula, so that they must be guarded against by careful delimitation of the boundaries of the area units, and careful definition of the time limits of the reference period.

Finally the Chandrasekar-Deming estimate assumes that the matching can be performed without error - or more exactly, that any matching errors will cancel out. In practice, matching is a bigger problem than might be expected, largely because, as mentioned above, it has to be performed without referring to the persons making the field reports. The criteria for a match cannot be laid down in such a way as to ensure correct matching. If the criteria are too strict, then some identical events reported by the two sources will be classed as distinct - i.e. some a's will become b's or c's, leading to over-estimation. If the criteria are too lax, the opposite error will occur. In practice there will be errors of both types and the aim is not to eliminate them but to have them cancel out. To avoid arbitrariness a further field operation is generally necessary to check doubtful cases and/or to calibrate the matching criteria. Because of the independence requirement, this operation is generally allotted to a third category of field worker.

We turn now to some operational features of the system. The need to minimize geographical out-of-scope errors has led in most dual record systems to great emphasis on the mapping of sampling units. Generally the areas have been mapped with considerably more care than in most conventional surveys. In the enquiry itself the selected sample areas are always covered completely (cluster sampling), as in other African demographic surveys, and there is an initial house-numbering operation which is found essential for the success of the matching. 1/

Cluster sizes have varied from about 150 to 6 000 persons. There has been considerable controversy about this. If the optimum were computed by the standard methods (Chapter 7) it would probably be similar to the 300 suggested for single round surveys. 2/ But with the dual record method other considerations are important: larger clusters are relatively easier to map unambiguously; larger clusters allow the use of full-time registrars without the need for their transportation from one cluster to another; on the other hand smaller clusters ease the matching problem. The use of a sub-cluster for the survey operation within a large cluster for the registration has also been recommended, with one-way matching only. This provides a solution to the otherwise vexing problem of how to use full-time registrars while keeping down the cluster size for the survey; on the other hand it increases the mapping work and sacrifices the added rigour of two-way matching.

The registration operation is usually performed by a local resident, who makes visits typically once every month or every two months. In many projects he has visited special informants, or sub-registrars, instead of households themselves; when this system is used he visits the household only when he learns of an event. Some dual record projects have used the official civil registration instead of setting up their own registration, but this has seldom worked well, mainly because of matching difficulties.

1/ The house-numbering compromises the independence requirement to some extent, since both field workers draw on it. Errors due to faulty numbering or coverage in this operation are not corrected by the dual record system.

2/ The heavy initial investment in mapping would tend to raise the optimum but the long duration of the project with a fixed sample would tend to lower it.

The survey operation has typically been repeated at 3-monthly or 6 monthly intervals, but an annual interval has also been recommended. Questioning seems to have been retrospective in most projects rather than based on the follow-up principle.

Enumeration is usually de facto and events are recorded if they occur within the sample cluster. The projects in Liberia and Malawi were, however, exceptions to this rule; both used de jure enumeration, though with a very short qualifying period for residence (1 month).

Finally there is the problem of the denominator for the vital rates. In conventional surveys it is taken for granted that the survey which provides the numerator of the rates (the events) will also provide the denominator (the count of persons interviewed). In the dual record system this is not so obvious. It is reasonable to suppose that some of the errors of omission of events committed by the survey and rectified by the registration relate to omissions in the survey enumeration, that is, some events were missed because the relevant persons were missed and therefore not counted. In this sense the upward correction of the numerator of the rate has no counterpart in the denominator: if we take the denominator from the survey we will therefore over-estimate the rate. For this reason it has sometimes been suggested that in applying the dual record method the denominator should be taken from an independent source such as the census (brought up to date by extrapolation, if necessary). This could be done in two ways:

(i) We could use the up-dated census population of the selected sample units. However, this will work only if the units used by the dual record system are identifiable in the census results. In many cases they will not be, either because some other area unit has been used for the sampling or because of boundary revisions made during the very thorough mapping operation.

(ii) Or we can raise the numerator sample to the national (or regional) level, then divide by the up-dated census national (or regional) total. This will involve a very much larger sampling error since we will no longer be using a ratio estimate (see Chapter 8).

Considering these objections, together with the uncertainty of the census figures themselves and the still greater uncertainty in their up-dating, it is probably fair to conclude that in almost all African countries any dual record project should produce its own denominator rather than resort to the census.

Critique of the dual record system

Cost is often raised as an objection to the dual record technique. However the discussion of cost in relation to the follow-up survey applies again here. While cost per sample unit is undoubtedly much higher in a dual record system this is not a relevant criterion. Account must be taken of any reduction there may be in bias. As we showed above, if the available budget is imagined to become smaller and smaller, one of the cheaper methods must eventually become competitive, whereas if the available budget is large enough and if it is accepted that the dual record system gives a lower bias than any other, then it must ultimately be the most efficient way of spending the given budget.

The technique is clearly much more sophisticated than any other we have considered. But with this sophistication comes a greater complexity. We have, in effect, two multi-round surveys running simultaneously, plus a matching operation in the office, plus a further "field reconciliation" operation and in some cases a separate matching calibration operation. The initial mapping has to be especially thorough. Finally, special precautions are needed to keep the two main field operations independent. It has plausibly been argued that this is not the recipe to offer countries whose main problem is a limited managerial capability.

Most of the other criticisms that have been advanced have already been mentioned above. They concern the validity of the numerous assumptions that have to be made. The independence assumption, essential for the fourth cell estimate d=bc/a, has been objected to more than any other. However, this criticism has been countered by pointing out that the contribution of d to the final estimate is generally extremely small. For example, if each system achieves an 80 per cent coverage, d is estimated at 4 per cent, or say 2 per thousand population in the birth rate and 1 per thousand in the death rate. Such a figure is perhaps close to the limits of error of <u>any</u> system in a developing country. Thus the d correction is of marginal importance. While this seems a valid answer to critics who treat the Chandrasekar-Deming estimate as crucial, the argument can be stood on its head: if the d correction is unimportant then the independence requirement is less than crucial and some of the cumbersome arrangements to ensure independence can be relaxed. 1/

The above argument is based on the small size of the d-correction <u>as computed</u>. The question of the d-correction <u>as it ought to be</u> (i.e. the number of events <u>truly</u> missed by both operations) is another matter. The fact that the computed d is small justifies the argument that it makes little difference whether we use it or not; but the same fact does not, obviously, justify the argument that, with or without the correction we will have a reasonably good estimate. If the two operations are highly correlated, the "true" d will be large, the computed d will be small, and we will get a heavy underestimate.

Apart from the independence assumption, there is the assumption that "out-of-scope" errors can be eliminated, in space and in time, the assumption that matching rules can be manipulated so that matching error cancels out, and the assumption that a denominator for the rates can be found which corresponds in coverage to the numerator.

Some of the other objections mentioned for multi-round surveys apply equally to the dual record system, which itself of course includes a multi-round survey. Notably there is the delay in publication - normally longer even than in the follow-up survey - and the difficulty of organizing an effective pilot enquiry covering all aspects of the system.

1/ But precautions against collusion between the two field workers must remain. Collusing is harmful not, mainly, because it invalidates the Chandrasekar-Deming estimate but because it implies a breakdown of the dual system and hence a waste of money and effort.

A final problem is that of the basis of enumeration. For the registration the optimal procedure is the simplest: recording the events which occur within the sample area. But for the multi-round survey the optimal procedure would probably be a follow-up technique with recording of all events affecting the de jure population. These two requirements are conflicting. We must therefore either adopt a less-than-optimal procedure for one of the systems, or limit the matching to those events which are common to both definitions, that is, to events occurring in the area and relating to de jure residents. If the latter solution were adopted we would have to add in the small supplementary group to complete the picture, using information coming from a single source only.

All dual record systems have in fact succeeded in uncovering a substantial number of events missed by the enumerator responsible for the survey part of the dual system. It is tempting to conclude that the dual system gives a better estimate than a single-system survey. Such a conclusion is probably correct but it is not certain. Firstly, the events missed might be errors of overestimation in the dual system, that is:

(i) Out-of-scope events

(ii) Events already counted once but not identified in the matching

(iii) Events associated with persons omitted in the survey enumeration. 1/

Secondly, it is possible that, as a result of the complexity of a dual record project, those surveys which form one element of a dual system are less well conducted than those which stand on their own. If this were so, then poor results with the former would not necessarily condemn the latter.

It is therefore not legitimate to use the dual record system as a yardstick for judging the merits of other systems, much less for measuring the success of the dual record system itself. Nevertheless one special advantage of the dual system should be mentioned: it contains built-in measures, if not of success, at least of failure. If the proportion of succe successful matches (a/N in our table) is low, we know that something is going badly - probably the field work, possibly the matching. If it is very high, either everything is going well or there is collusion between the registrar and the enumerator. This kind of indicator is lacking in all single systems.

Finally the dual system shares an important advantage with the single system multi-round survey. Any system which continues over a long period and involves multiple repetitions of the same operations can expect to benefit from accumulating experience: bad methods are improved, unreliable personnel are removed, everyone learns from past mistakes and increases his efficiency. 2/

1/ Although this represents error by the survey enumerator its effect will approximately disappear if a survey alone is being used, but will lead to an overestimatdd rate if the dual record method is being used with the survey enumeration in the denominator.

2/ Note, however, that these are potential, not certain, benefits. If morale is allowed to sink, personnel may become more efficient only at avoiding work and concealing their deficiencies.

11.3 CONCLUSIONS

In this chapter we have given a fairly severe critique of both the multi-round follow-up survey and the dual record system. It would be a mistake, however, to conclude from this that any other system is favoured, for example, the single round survey with "Brass techniques" of correction. Equally strong objections could be listed against this (see Chapter 12). The fact is that all systems so far suggested appear to be subject to quite serious sources of error. While their relative ratings in this respect are a matter of controversy, nobody denies that each one of them has significant defects. One purpose of this chapter has been to draw attention to these so that they may be taken into account, with other factors, when a choice of method has to be faced. This choice is further discussed in Chapter 12.

It may be noted that the "critiques" in this chapter are based on errors that *might* occur, with little reference to any hard evidence showing that particular types of error *do* occur. Such evidence exists. There have been clear demonstrations of defective results from many individual projects of all kinds, whether single round surveys, multi-round surveys or dual record systems. However, each survey is a special case; if errors are found in a given survey they may be attributable to the poor quality of the work in that survey rather than to the design; moreover the different sources of bias may vary in importance in different circumstances. This difficulty may yield in the end to circumstantial evidence when we have data for a large number of enquiries of many kinds, but we have not yet reached this position.

For the present, only one firm conclusion seems possible. Whatever the relative merits of the different data collection systems available, in all systems the results depend closely on the quality of the field work. No gimmick has yet been found which can substitute for well-trained, closely supervised, highly motivated field workers.

References

Cantrelle, P. (1974) The Multi-round Demographic Survey Method, Laboratories for Population Statistics, Scientific Report No. 14, Chapel Hill N.C.

Marks, E., Seltzer, W. and Krotki, K. (1974), Population Growth Estimation: A Handbook of Vital Statistics Measurement, Population Council, New York.

CHAPTER 12

PRINCIPLES OF ANALYSIS

The analysis of demographic data is far too big a subject for full treatment in this manual. Nevertheless, some idea of the principles of such analysis is indispensable to the survey organizer wishing to choose the best techniques for data collection.

The classical techniques of demographic analysis are described in many textbooks and it is assumed that these are already available. A reference list appears at the end of the chapter. In this chapter we summarize the basic principles of those less familiar special analytical techniques which have been developed for drawing conclusions from data which are known to be seriously defective. We emphasize, especially, the assumptions on which these methods are based and the sensitivity, or "robustness", of these methods when errors occur in these assumptions - that is, the extent to which the conclusions will be distorted by an error of given magnitude in the assumptions. In a somewhat analogous way, we discussed in Chapter 11 the potential errors involved in those special techniques of data collection which seek to provide reliable demographic estimates either direct from the data, or with a minimum of manipulation. The survey planner, faced with the decision between different methods of data collection, needs to be well informed about all these significant potential sources of error.

Whatever method is used, the final estimates of fertility, mortality and growth will be subject to certain margins of error. Obviously the smaller these margins of error, the happier everyone will be. Clearly it is to be hoped that by adopting more elaborate procedures such as the multi-round follow-up or dual-record systems, the margins of error will be reduced. But the extent to which these hopes will in fact be fulfilled is precisely what we do not know. We cannot, on the basis of existing data, make any firm predictions as to how far the increased cost, time and effort which the more elaborate procedures entail will pay off in terms of increased accuracy.

What we <u>can</u> say with absolute certainty, however, is that there is <u>no</u> method which can be regarded as infallible. Whatever technique is used there is no guarantee that the estimates of the vital rates eventually obtained will not be subject to substantial errors. Thus all data should be assumed guilty until they prove themselves innocent; they should never be accepted at their face value unless corroborated by other evidence. Thus the analyst is duty bound to use every weapon at his disposal, and to make as many estimates, from as many different sources, as possible. The "spread" of these estimates will thus provide some indication of their reliability.

This task has been facilitated by the development, during the last twenty years, of a substantial body of analytical methodology. These analytical techniques constitute tests of internal consistency as well as methods of demographic estimation and of adjustment for reporting errors. They can and should be applied to data obtained from multi-round follow-up surveys and dual record systems as well as to single round data. Indeed if a country cannot be assured of the services of a competent demographer capable of making a thorough analysis,

it would do better not to embark upon the survey at all: no man should eat a large meal unless he can be reasonably sure that he will be able to digest it.

A full description of the analytical techniques, together with worked examples, would be beyond the scope of this manual. It would require a manual on its own; indeed various such manuals have been, and are being, prepared, references to which will be found at the end of this chapter. But a brief outline of the principles involved, seen against the background of the available sources, together with a discussion of the underlying assumptions and the biases which may result from the failure of these assumptions, is essential for the argument of this chapter.

12.1 FERTILITY

Sources

Given the questions recommended in Chapter 5 and the tabulations recommended in Chapter 10, the following data should be available:

(1) The distribution of the population by sex and age.

(2) Current fertility: births occurring during a recent calendar period, tabulated by age of mother and parity, derived from:

(a) Retrospective questions on births in the last twelve months or on the date of last birth;

and/or

(b) Births observed by follow-up or dual record methods.

(3) Lifetime fertility: distributions of women in each age group by the number of children ever born alive, derived from retrospective questions on numbers of children even born or from pregnancy or maternity histories.

Analysis

Two principal techniques of analysis have been developed and widely used with African data. (They are not the only methods which have been used.)

(1) Stable population estimates. Given indices (a) of infant and child mortality (e.g. the life table survivors at age 2 derived from proportions of children surviving to mothers aged 20-24) and (b) of the shape of the age-specific fertility distribution (e.g. the mean of the distribution derived from the data on current births), the level of fertility may be estimated by comparing the reported age structure with those of stable models. These estimates are based on the following assumptions.

Assumption (a): That fertility has remained roughly constant for a more or less indefinite period prior to the survey or census, and that mortality has only been changing relatively gradually. If in fact infant and child mortality has been declining rapidly, or even more important, if

fertility has been changing, appreciable bias can be introduced. The United Nations Manual Estimating Basic Demographic Measures from Incomplete Data provides a table of correction factors for adjusting the fertility estimates for declining mortality and/or rising fertility. The selection of the appropriate correction factor from this table is determined by the rate and duration of the changes, and unfortunately information on these points is rarely available. However, some informed guesses can often be made which will enable the analyst to get an idea of the order of magnitude of the necessary adjustments. Thus in the case of the 1969 census of Kenya, where mortality had undoubtedly been falling and there was reason to think that fertility was also rising, adjustments of up to 8 per cent were made in the stable population estimates.

Assumption (b): That the age distribution has not been distorted by migration. Since migration is almost always age-sex selective, an appreciable bias may be introduced into the fertility estimates of populations containing a sizeable proportion of persons of foreign origin, or where large numbers of persons have left the country. Normally if the population has experienced a net emigration, fertility will be over-estimated, and vice versa. However steps can sometimes be taken which may reduce, though they will never eliminate, such bias. Thus in the case of a country experiencing net immigration, the stable population analysis should be based on the age distribution of nationals only, aliens being excluded; where there has been emigration, and a question on absent members of the household was asked in the survey or census (see above Chapter 5 section E), the absentees should be included with the resident population.

Assumption (c): That the relative pattern of age-specific mortality in the population corresponds with those of the life tables used for the construction of the stable population models. Thus if the relative levels of adult and child mortality in the population under study differ markedly from those of the selected model life table, an appreciable bias may be introduced. For example, in the Malawi Population Change Survey adult mortality was found to be unusually low in relation to infant and child mortality; stable population models constructed on the basis of the available mortality data yielded fertility estimates about 7 per cent higher than those based on the Coale-Demeny "West" models. To forestall such bias, it is clearly advisable that the stable population models should be tailored to fit, not only the infant and child mortality of the population under study, but also the adult mortality as well.

Assumption (d): That the indices of the age structure adopted for the preferred estimates of fertility (e.g. the proportion under 15 or under 35) had not been biased by age misreporting. In view of the distortions of most African age distributions by misreporting, this is clearly a shaky assumption, and the margin of error attached to the estimates is clearly reflected in the variation between the estimates based on different indices. For example, when the female age distribution for Niger (1960) is matched against the Coale-Demeny models based on the "West"

mortality schedule at "Level 8" (e_0 = 37.5 years), the proportion recorded as under 10 years of age implied a gross reproduction rate of 3.8; the proportion under 15, however, indicated a GRR of only 2.9.

(2) The comparison of cumulated current fertility and average parity. (Commonly known as the "Brass method".) The age-specific fertility rates obtained from the current data may be cumulated in such a way as to make them comparable age group by age group, with the figures of average parity (i.e. the mean number of children ever born) derived from the lifetime fertility data. The relative discrepancies found for the younger age groups of women are then used as correction factors to make pro rata adjustments to the fertility rates over the whole reproductive age range. (Brass et al. 1968; United Nations 1967.) An extension of this technique consists in its application by birth order: the current fertility rates by age and birth order are cumulated and compared with the proportions of women of equivalent minimum parity; the trends in the resultant ratios by both parity and age should be examined before a decision is made on the appropriate correction factors. These methods are based on the following assumptions:

Assumption (a): That the average parity of the younger women has been correctly reported and is representative of the current level of fertility. The validity of this assumption has sometimes been open to doubt: the full distributions of women by the numbers of children born have sometimes revealed cases of women in the three youngest age groups who were reported to have borne numbers of children which, if not actually impossible, were at least extremely unlikely if their reported ages were correct. Such bias could arise if there was a tendency to attribute to the women concerned children born to their husbands by other wives. Various measures may be adopted to compensate for such bias: the women with suspiciously large numbers of children may be omitted when calculating the average parity; or the adjustment factors may be based on ratios for the lower birth orders only.

Assumption (b): That the relative under-reporting (or, more rarely, the over-reporting) of the current births is independent of the age of the women; or, in other words, that the data on current fertility provides valid information on the shape of the age-specific fertility distribution, even though the reported level may be faulty. In some cases (notably the 1960 Ghana PES, the 1962 Kenya census, the 1966 Swaziland census, and the 1967 Tanzania census) this assumption has not in fact been valid: the current age-specific fertility rates were biased towards the older age groups of women so that when cumulated and compared with average parity the implied adjustments were implausibly large. Thus while the comparison showed clearly that the current fertility data had been subject to substantial errors, the size and nature of the necessary adjustments could not be determined with precision. In such circumstances the analysis of the current data by birth order may be illuminating. It has also been found that this type of bias has been appreciably reduced when the question on births in the last 12 months has been replaced by one on the date of the last live birth.

Assumption (c): That the mis-reporting of the ages of the women in the child-bearing age groups will have affected both the current fertility rates and the reported average parity in such ways as will have compensating effects on the "P/F" ratios. The validity of this assumption clearly depends on the possible associations between the age misreporting and both current and lifetime fertility. Calculations based on models incorporating combinations of different possible types of association have indicated that the assumption should be broadly true except in the case of rather implausible combinations, such as over-statement of age being positively associated with current fertility but negatively associated with lifetime fertility, or vice versa.

When fertility estimates have been made for the same populations by both stable population analysis and by the comparison of cumulated current fertility and average parity, agreement has occasionally been good, but generally the stable population estimates have tended to be rather higher. Important exceptions, however, have been found in those censuses and surveys where the results of the "Brass method" have been biased by the failure of assumption (b) above. Where the current fertility rates have been derived from a question on the date of the most recent birth, it may also be illuminating to try to assess the various elements contributing to any shortfall in the cumulated current rates when compared with average parity. The view formerly held that all errors in the current data could be attributed to faulty estimation of the "reference period" has been shown to be too simple. The causes of such errors may in fact be multiple and complex; they may include not only dating errors, but also such factors as various forms of non-response and even the designation of the wrong birth. Where the information has been obtained from maternity or pregnancy histories, an even more thorough and detailed reconciliation of the cohort and cross-sectional data may be possible.

12.2 MORTALITY

Sources

Given the questions recommended in Chapter 5 and the tabulations recommended in Chapter 9, the following data should be available:

(1) Current mortality: numbers of deaths occurring during a recent calendar period by sex and age, derived from:

(a) Retrospective questions on deaths in the last 12 months

and/or

(b) Deaths observed by follow-up or dual record methods.

(2) Proportions of children ever born who were still living or who had died, by age group of mother, derived from questions on lifetime fertility.

(3) Proportions of persons in each age group with (a) father alive, and (b) mother alive, by sex of respondents, derived from the questions on survival of parents.

Analysis

As with fertility, the following discussion of techniques of mortality analysis is by no means exhaustive; the methods described are those which are readily available for use with African data, and which serve to illustrate the argument of this chapter.

(1) Estimation of death rates from proportionate distributions of deaths and population by age. From the data on current mortality, the proportion of deaths in each age group may be calculated, together with the corresponding proportion of the population in each age group. Both distributions are then cumulated from the oldest ages downwards, so as to obtain the proportions of deaths and population over the age of y (denoted by D_y and P_y respectively). At the same time the proportion of the population aged y (denoted by N_y) may be calculated as one-tenth of the ten-year age group y-5 to y+4. The ratio D_y/P_y may be plotted against the ratio N_y/P_y for different values of y. If the points are found to lie approximately along a straight line, the slope of this line may be taken as an estimate of the crude death rate (Brass 1973).

This technique is based on two principal assumptions:

Assumption (a): That although the numbers of deaths may generally be under-reported, the omissions are proportionately the same at all ages, and that the percentage distribution of deaths by age remains valid. If it is suspected (as may commonly be so) that a larger proportion of infant and child deaths have been omitted than is the case with adult deaths, the infant and child deaths may be omitted from the calculations altogether. The death rate then obtained from the slope of the line will represent the crude death rate which would have occurred had there been no deaths below the age chosen as the cut-off.

Assumption (b): That the population approximates to stable, or at least quasi-stable, conditions. The robustness of the technique when fertility is in fact changing, or when the age distribution has been distorted by migration, has not yet been fully determined, and further research in this direction is required.

At the time of the preparation of this manual, this method of mortality estimation is relatively new and has been applied less extensively to data from Africa than to those from Asia, Latin America and Oceania. All indications suggest that it will prove a useful addition to the demographer's armoury. However, further research is needed on its robustness, not only in conditions of non-stability, but also to age mis-reporting of both population and deaths. The method is sensitive to sampling errors and would not work satisfactorily, for example, with the data from the Malawi Population Change Survey, where the annual number of deaths actually reported in the sample was some 640 and which, when broken down by sex, age group and stratum, were clearly subject to large sampling errors. In general if the conditions are such that the method cannot fruitfully be applied, this fact will be self-apparent from the distribution of points on the graph, which will not lie in anything remotely resembling a straight line.

(2) Estimation of infant and child mortality from proportions dying among children ever born, tabulated by age of mother. The proportions of children ever borne by women aged 20-24, 25-29 and 30-34 who were alive and dead at the time of the survey may be converted into estimates of the life table survivors ($_1l_x$) at ages 2, 3 and 5 respectively, using the techniques devised by Brass (Brass et al. 1968; United Nations 1967) and Sullivan (Sullivan 1972). These techniques are based on the following assumptions.

Assumption (a): That the patterns of fertility and mortality approximate roughly to those of the models used for the development of the conversion factors. Brass's method has been shown to be reasonably robust in this respect, and fairly large divergence from the basic models can be tolerated before serious bias is introduced into the estimates. Sullivan's method provides a choice of regression equations corresponding to the four Coale-Demeny families of model life tables. One selects the model which is thought to resemble most closely the mortality in the population under investigation.

Assumption (b): That fertility and mortality have been roughly constant during the decade preceding the survey. The methods have been shown to be reasonably robust to changes in fertility. If infant and child mortality has in fact been falling the estimates obtained will represent a rough average for a relatively short period (generally less than a decade) prior to the survey rather than the level actually current at the time of the survey. What evidence is available on rates of decline in infant and child mortality in Africa suggests that in the great majority of cases such bias will be negligible.

Assumption (c): That infant and child mortality are not highly correlated either with the age of the mother or with mortality of the mother. In fact it is known that infant mortality among children borne by very young mothers - those under the age of 20 - tends to be abnormally high; but for mothers over 20 years of age the bias is in all probability negligible. Any correlation between the mortality of the children and that of the mothers is likely to be positive; since we only have data on the mortality of children borne by surviving mothers, the estimates of mortality are likely to be too low rather than too high. However any such bias will be slight for mothers under the age of 30.

Assumption (d): That if the data on lifetime fertility have been subject to omissions or faulty inclusions, the errors have affected the reports on the numbers of living and dead children in the same proportion. This is undoubtedly the weakest of the basic assumptions on which the methods depend. In the case of omissions, it is more probable that dead children will have been left out than living children; faulty inclusions, such as those of children borne to the husband by another wife, are more likely to have been of living than of dead children.

Thus while the failure of assumption (b) might lead to a slight overestimate of infant and child mortality, the failure of assumptions (c) and (d) will lead to under-estimates. Since the latter are more probable, the mortality estimates obtained by these means should be regarded as minimum estimates, more likely to be too low than too high.

(3) Estimation of adult mortality from proportions of persons with surviving parents. The proportions of persons in each age group with (a) mothers alive and (b) fathers alive may be converted into probabilities of surviving from a base age B to an age B+N, where N is the mid-point of the respondents' age group (Brass & Hill 1973, INED-INSEE-ORSTOM-SEAE 1973). Again the assumptions on which the procedures are based are as follows:

Assumption (a): That the patterns of mortality and fertility approximate to those of the models used for the development of the conversion factors. Again the technique has been proved to be robust in this respect. There is, however, a special feature which should be discussed under this heading. In the case of the estimation of infant and child mortality, the selection of the conversion factors were largely based on the same information - the data on lifetime fertility - as provided the basic proportions of children dying. In the case of parent survival, however, the index used for the selection of the conversion factor - the mean age of fathers and of mothers at the birth of their children ($\bar{M}$) - must first be calculated from other sources of data, all of which are subject to errors. If the $\bar{M}$ is overestimated, mortality will be under-estimated, and vice versa. In the light of what is known about the errors in the data, $\bar{M}$ is more likely to be over-estimated than under-estimated.

Assumption (b): That fertility and mortality have been constant for an indefinite period preceding the survey. Changes in the level of fertility should not affect the estimates provided that the shape of the fertility distribution is not altered; but if the shape has been changed in such a way as to alter the position of the mean, the resultant bias will be similar to that arising from the faulty estimation of $\bar{M}$. If adult mortality has been falling, the estimates will be rather higher than the true level current at the time of the survey, but even in cases of rapid and prolonged mortality decline, the overall bias is likely to be relatively slight. This is because adult mortality rises rapidly with age, so that the cumulated mortality experience of any cohort of adults tends to be dominated by recent deaths.

Assumption (c): That the mortality of the parent is independent of the numbers of offspring living in the population concerned (who could all, in principle, report on the same parent). Thus a man with, say, ten living children may be reported ten times, whereas a man with no children won't be reported at all. If there is a correlation between the numbers of living offspring and the mortality of the parent, the mortality estimates will be biased. Unfortunatley no data are available which would enable even a rough estimate of the magnitude of the bias to be made. Indeed it is not easy even to envisage which way the bias might go, and the direction may well vary from population to population. Given the patterns of socio-economic differentials in fertility and in infant and child mortality commonly found in Africa, it would seem more probable that the resultant bias would be downwards rather than upwards. A possible method of combatting this bias is to include additional questions as to whether the respondent is the eldest surviving child of his/her father or mother. Separate mortality analyses may then be made for eldest

children only; the multiple reports on the same parents will thus be avoided, though the problem of the childless persons still remains. 1/

Assumption (d): That in the event of foster parents being substituted for true parents in the responses, the ages and mortality of the foster parents should be similar to those of the true parents. In this respect the principal danger arises (as has already been noted in Chapter 5) from those cases where adoption occurred because of the mortality of the true parents. In these circumstances mortality would clearly be under-estimated. In all the censuses and surveys conducted in Africa and where the "orphanage" questions have been asked, the mortality estimates derived from the responses recorded for children under 10 years of age have been incompatibly low in relation to those for older age groups. This feature may well be attributable to the adoption bias. For respondents who are themselves adults there is every reason to hope that such bias is minimal. As has been noted in Chapter 5, every effort should be made to forestall such errors by correct wording of the questions in the field.

Thus although failure of assumption (b) would lead to the over-estimation of mortality, that of the other three assumptions would probably lead to under-estimates. It therefore again seems more likely that the mortality estimates will be too low rather than too high, and should once more be regarded as minimum values.

(4) Use of model life tables. Model life tables have become an essential tool for demographic analysis in developing countries. They may be used for a wide variety of purposes: for graduating irregularities in age-specific mortality rates, for completing missing sections of life tables (e.g. by linking the infant and child mortality rates derived by method (2) above with adult mortality rates derived by (3)), for testing the consistency and plausibility of various estimates, for estimating mortality from data on intercensal survival, and for the construction of stable population models and of population projections. Several different systems of model life tables are available; at the time of the preparation of this manual the four principal ones are:

(i) The United Nations single-parameter models (United Nations 1955 and 1956);

1/ Since the problem is essentially one of incorrect weighting, it might be argued that a preferable procedure would be to add a question on the number of living siblings of each respondent. Responses on parents' survival could then be re-weighted by the reciprocal of the total number of siblings (including the respondent). Unfortunately this procedure cannot be recommended at the present time, for various reasons: no techniques for analyzing the results have yet been devised (they would require new sets of conversion factors, based on new models of fertility and mortality, for which a large part of the basic data is lacking); the questions would be complex (one should distinguish same-father and same-mother siblings) and almost certainly liable to substantial response errors; and they would not in fact produce the "correct" weighting since childless persons will still not be represented.

(ii) The Coale-Demeny models: four "families" of single-parameter models, named after the four points of the compass, with different relative patterns of sex-age-specific mortality (Coale and Demeny 1966);

(iii) The Brass two-parameter models, based on the linear logit transformation of a standard life table (Brass et al. 1968; Brass 1971; Carrier and Hobcraft 1971);

(iv) The Ledermann models: seven families of single-parameter models and three families of two-parameter models, all derived from the same original data but varying according to the "point(s) of entry" - i.e. the index of mortality used for the selection of the model (Ledermann 1969).

The choice of which of these systems to use must be largely determined by the use to which they are being put and the nature of the data. But whatever the circumstances, a common feature underlies the use of model life tables in Africa: they are being used in lieu of life tables constructed from complete death registration and population data with accurate information on ages for the population concerned. In fact no model taken "off the peg" on the basis of only one or two parameters can be expected to represent the mortality of a population as faithfully as a "made-to-measure" life table constructed from accurate statistics derived from that population itself. The nature and magnitude of the errors will of course vary with the circumstances of the case. In some instances they may be negligible in comparison with the errors in the estimation of the basic parameters; but elsewhere they may be considerable. Undoubtedly the largest potential errors are those which are liable to arise from the use of single-parameter models selected on the basis on information on infant and child mortality only; experience has shown that adult mortality may in fact vary widely on either side of any of the available single-parameter models 1/: hence the importance of obtaining some reliable indices of adult mortality, and facilitating the use of one of the two-parameter systems.

12.3 CONCLUSION

From the foregoing it will have become apparent that the data on births and deaths occurring in a specified calendar period are not the only sources of information on fertility and mortality; questions on lifetime fertility, on survival of parents, and on sex and age can also yield valuable estimates. These questions can be asked just as well in a single round survey as in a multi-round or dual system operation; the latter can be expected to effect improvements in the current data only.

1/ Although generalisation on this point may be both premature and dangerous, it would seem that in Africa adult mortality is more often than not somewhat lower in relation to infant and child mortality than is depicted by most single-parameter models. The use of such models will therefore tend to overestimate adult mortality.

Experience gained, at least in Africa, from analyses of the type described above, has shown that the estimates of fertility and mortality derived from the information on lifetime fertility, etc., have generally been higher than those shown by the current data alone, whatever the method by which the latter were collected. This is particularly true of the mortality estimates: the infant and child mortality rates indirectly derived from proportions dying among children ever born have almost invariably been appreciably higher than those based on direct observations of current deaths, even when the latter were made by dual record methodswith adjustments on the basis of the Chandrasekar-Deming correction; likewise the estimates of adult mortality derived from questions on orphanage have proved higher than those based on current deaths, though our experience in this direction is much more limited. Yet we have seen from our discussion of the assumptions and potential biases of the indirect methods of estimation that they are more likely to yield results which are too low rather than too high, and that such estimates should be regarded as minimum values. In the light of this reasoning, the indirect estimates have sometimes been used to "correct" the reported current rates; by implication this amounts to acceptance of the indirect estimates as the truth (or at least nearer the truth) and recognition that the observed current rates were biased. Does this mean that there is no point in collecting data on current events, particularly when the methods of collection are as complex, as costly and as time-consuming as the dual record system? This is the question we will now consider.

Originally, the multi-round and dual record systems were evolved essentially as part of the search for a method of data collection which would yield results of such accuracy that they could confidently be accepted at their face value. It is all very well to rely on analytical corrections (sometimes based on assumptions of somewhat dubious validity) before arriving at the final result, but wouldn't it be better, it has been asked, if the data didn't need correcting? Prevention, after all, is better than cure. Unhappily these hopes have not yet been fulfilled: estimates derived even from the dual record method have still been shown to be in need of correction, sometimes substantial. Yet despite this there are still advantages to be gained from these methods: firstly, they offer the prospect of improving what has clearly been the weakest element in African demographic data; secondly, information on current fertility is still an essential component of the "Brass method" of estimation; thirdly, until the recent development of the "orphanage" approach (still regarded askance by some), data on current deaths were virtually the only source of information on adult mortality in Tropical Africa. 1/

Furthermore, the fact that we have not yet been able to dispense with correction procedures is no argument for not trying to improve the data.

1/ An alternative technique of obtaining estimates of adult mortality is of course inter-censal survival, but it has rarely been possible to use it with African data. Many African countries have only held one census, and for those which have done two or more the comparison of the results has all too often been vitiated by varying completeness of coverage or by migration.

The better the data the better will the estimation procedures work; the smaller the size of the necessary correction, the smaller will be the margins of error attached to the final estimates. Note, however, that reduplicating the interviews (whether by multi-round surveys or dual record systems) is not the only approach in this search for better data. We should also seek to forestall the response errors before they occur. As it is, we know far too little about what really goes on between enumerators and respondents. How is it that questions become garbled and misunderstood? How often are crucial questions never in fact put at all, and the answers merely inferred, often faultily, from other information? How does it come about that certain types of events tend to be omitted, or erroneously included, or mis-dated? How far are such errors due to ignorance and how far to misunderstanding? All too often in the past both the schedules and the instructions given to enumerators have been concerned only with defining the information to be obtained, and no attention or guidance has been given as to the nature and sequence of questions which the enumerator must put in order to elicit this information. It is scarcely surprising if, left to his own devices in this respect, he sometimes make a mess of it. Research on these aspects may well prove the most rewarding approach to the improvement of African demographic statistics.

At the beginning of this chapter we advanced the view that the analyst should use every weapon at his disposal and make as many estimates from as many different sources as possible. He will thus eventually be faced with a range of values from which he must select his preferred final figure. In so doing he should examine critically the basis of each estimate and endeavour to assess how far it may have been biased by the failure of any of the underlying assumptions. Such assessment implies of course the use of subjective judgement, and to some persons this procedure is abhorrent: no two analysts, it has been pointed out, will necessarily arrive at the same results, so that one of the basic principles of all scientific research is flouted. The alternative of pinning our faith unquestioningly on the face value of the data has of course its attractions. But in our opinion it cannot be justified. African demographic statistics have not yet reached the stage which will permit us to avoid the necessity of having to think.

References

Brass, W. et al. (1968) The Demography of Tropical Africa, Princeton.

Brass, W. (1971) "On the Scale of Mortality", in Biological Aspects of Demography (ed. W. Brass) London.

Brass, W. (1973)"Note on a Method for Estimating Mortality from Distributions of Deaths and Population by Age without Knowledge of the Relation of Absolute Numbers", Note circulated at the Conference of the International Union for the Scientific Study of Population, Liege 1973.

Brass, W. and Hill, K. (1973) "Estimating Adult Mortality from Orphanhood", International Population Conference, Liege 1973, Vol. 3.

Carrier, N. and Hobcraft, J. (1971) Demographic Estimation for Developing Societies, London.

Coale, Ansley J. and Demeny, Paul (1966), Regional Model Life Tables and Stable Populations, Princeton.

INED-INSEE-ORSTOM-SEAE (1973), Source et analyse des données démographiques Deuxième partie: Ajustement de données imparfaites, Paris.

Ledermann, Sully (1969), Nouvelles tables-types de mortalité, Paris.

Sullivan, J.M. (1972), "Models for the Estimation of the Probability of Dying Between Birth and Exact Ages of Early Childhood", Population Studies, Vol. XXVI No. 1.

United Nations (1955), Age and Sex Patterns of Mortality: Model Life-Tables for Under-Developed Countries (ST/SOA/Series A/22), New York.

United Nations (1956), Methods for Population Projections by Sex and Age (ST/SOA/Series A/25), New York.

United Nations (1967), Methods of Estimating Basic Demographic Measures from Incomplete Data (ST/SOA/Series A/42), New York.

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Table 1. Population by sex and single years of age

Issue | Page 1 Annex 1

Date

Author

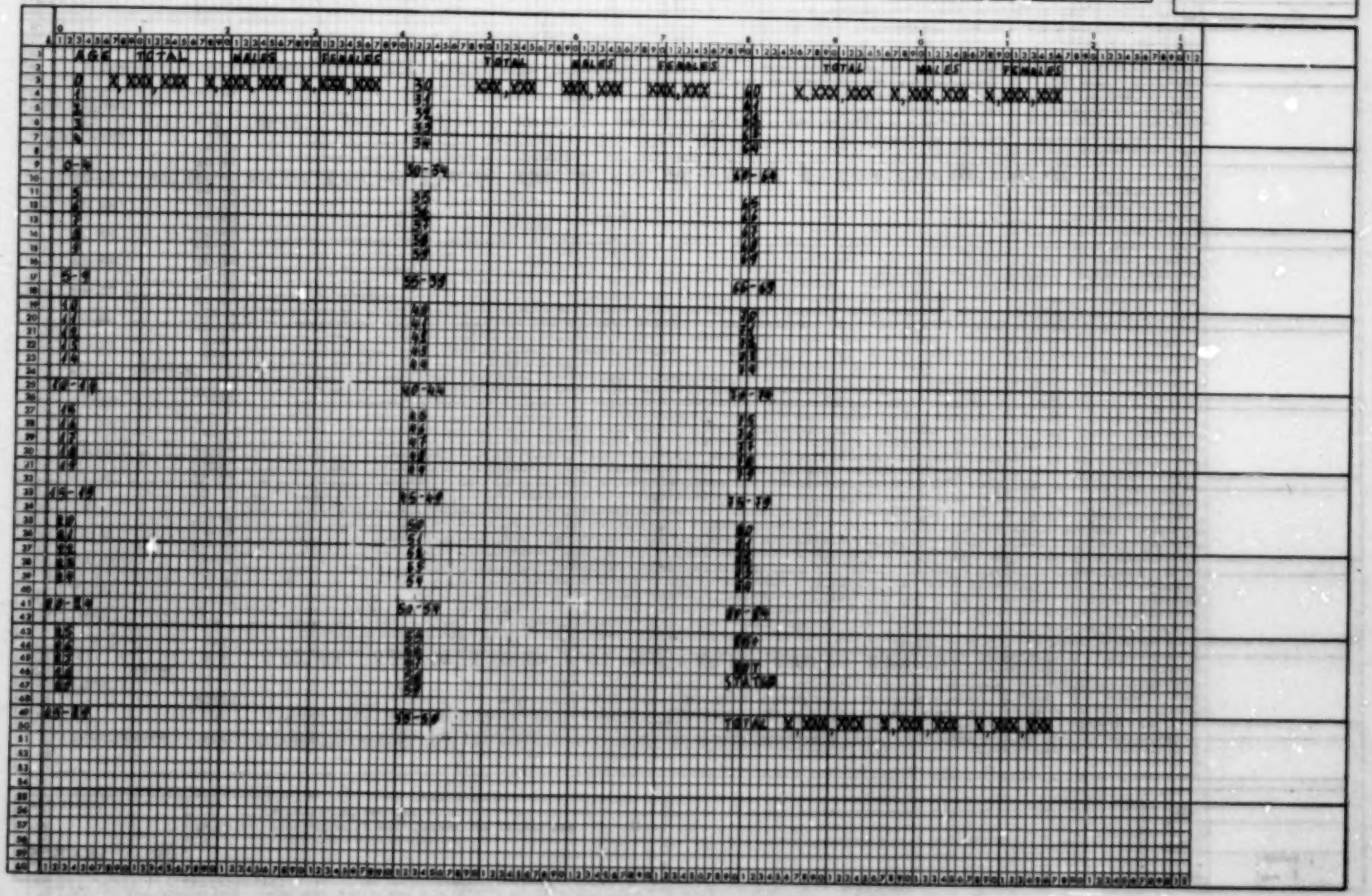

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Table 2. Population by sex, 5-year age groups and survival of parents

Page 2
Annex 1

AGE GROUP	TOTAL	FATHER ALIVE	FATHER DEAD	FATHER N.S.	MOTHER ALIVE	MOTHER DEAD	MOTHER N.S.
MALES							
0-4	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX
5-9							
10-14							
15-19							
20-24							
25-29							
30-34							
35-39							
40-44							
45-49							
50-54							
55-59							
60-64							
65-69							
70-74							
75-79							
80+							
N.S.							
TOTAL							
FEMALES							
0-4							
5-9							
10-14							
15-19							
20-24							
25-29							
30-34							
35-39							
40-44							
45-49							
50-54							
55-59							
60-64							
65-69							
70-74							
75-79							
80+							
N.S.							
TOTAL							

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Table 3. Females aged 15 years and over by 5-year age groups and 5-year age group of husband

Issue | Page 3 Annex 1

Date

Author

AGE GROUP OF HUSBAND	TOTAL	AGE GROUP OF WOMEN								
		15-19	20-24	25-29	30-34	35-39	40-44	45-49	50+	N.S.
15-19	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX
20-24										
25-29										
30-34										
35-39										
40-44										
45-49										
50-54										
55-59										
60-64										
65-69										
70-74										
75-79										
80-84										
85-89										
90-94										
95+										
N.S.										
TOTAL										

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Table 4. Females aged 15 years and over by 5-year age groups, with number living at home, number living elsewhere with total children ever born, and number dead

Issue | Page 4 Annex 1

Date

Author

AGE GROUP	TOTAL WOMEN	TOTAL BIRTHS	CHILDREN AT HOME	CHILDREN AWAY	CHILDREN DEAD
15-19	X,XXX,XXX	XX,XXX,XXX	XX,XXX,XXX	XX,XXX,XXX	XX,XXX,XXX
20-24					
25-29					
30-34					
35-39					
40-44					
45-49					
50-54					
55-59					
60-64					
65-69					
70-74					
75+					
N.S.					
TOTAL					

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Table 5. Females aged 15 years and over by 5-year age groups and number of children ever born

Issue | Page 5 Annex 1

Date

Author

AGE GROUP	TOTAL WOMEN	NUMBER OF CHILDREN EVER BORN											
		0	1	2	3	4	5	6	7	8	9	10+	N.S.
15-19	XX,XXX	XX,XXX	XX,XXX	XX,XXX	XX,XXX	XX,XXX	XX,XXX	XX,XXX	XX,XXX	XX,XXX	XX,XXX	XX,XXX	XX,XXX
20-24													
25-29													
30-34													
35-39													
40-44													
45-49													
50-54													
55-59													
60-64													
65-69													
70-74													
75+													
N.S.													

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Table 6. Females aged 15 years and over by 5-year age groups, date of the most recent live birth, and survival of the child

Issue | Page 6 Annex 1

Date

Author

ALL CHILDREN	AGE GROUP	TOTAL WOMEN	LAST 15 MONTHS	15-24 MONTHS	2-4 YEARS	5+ YEARS	LAST YEAR MONTHS	YEAR BEFORE MONTHS	CHILDLESS WOMEN	MOTHERS DAUGHTERS
	15-19	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX
	20-24									
	25-29									
	30-34									
	35-39									
	40-44									
	45-49									
	50-54									
	55-59									
	60-64									
	65-69									
	70-74									
	75+									
	N.S.									
	TOTAL									

REPEAT FOR: (1) LAST-BORN CHILD ALIVE

(2) LAST-BORN CHILD DEAD

(3) LAST-BORN CHILD NOT STATED

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Table 7. Females bearing children during the preceding 12 months by 5-year age group and no. of children ever born

Issue | Page 7 ANNEX 1

Date

Author

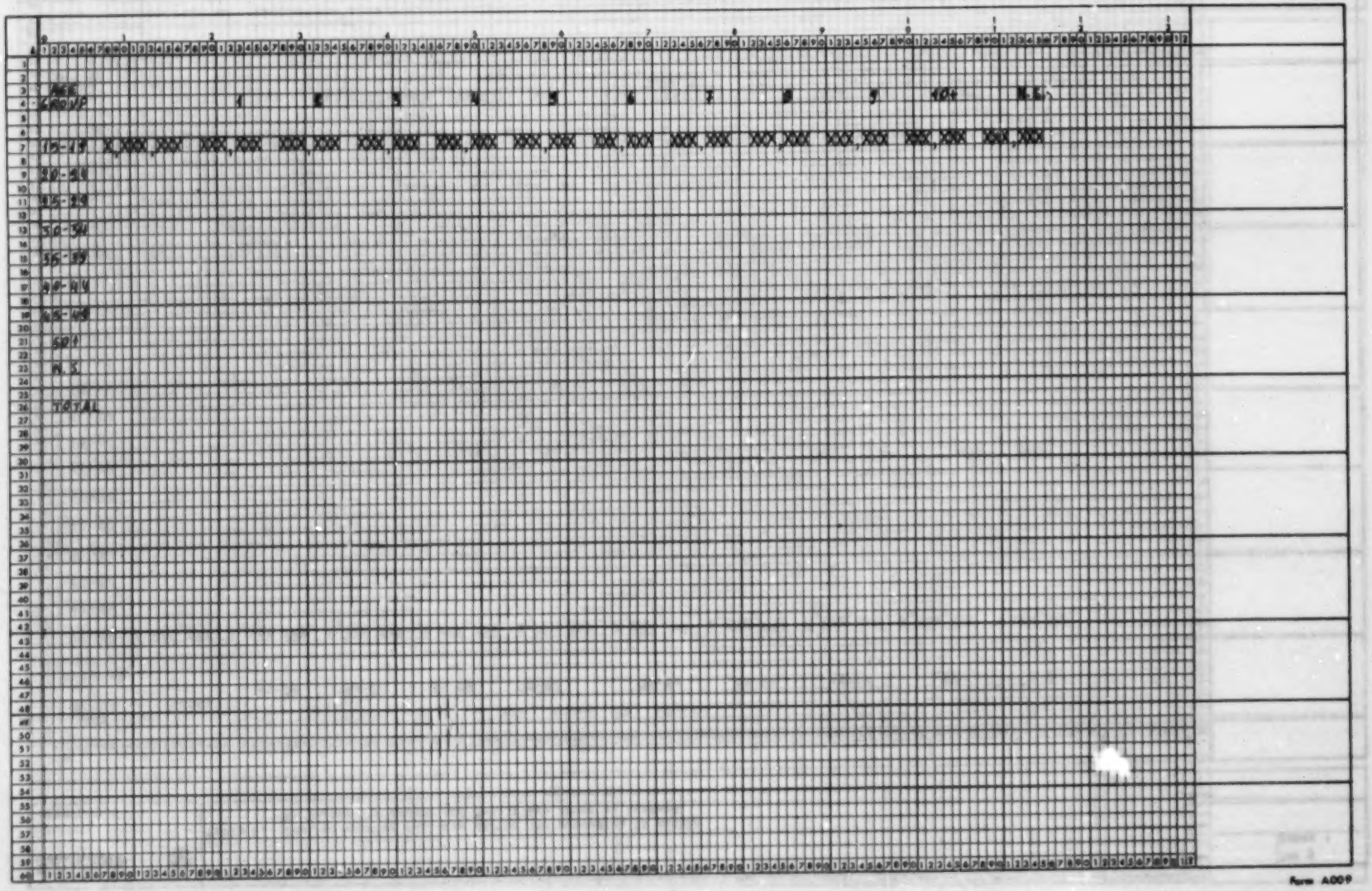

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Table 8. Females bearing children during the preceding 12 months by 5-year age groups and 5-year age group of husband

Issue | Page 8 Annex 1

Date

Author

AGE GROUP OF HUSBAND	TOTAL	AGE GROUP OF WOMEN									
		15-19	20-24	25-29	30-34	35-39	40-44	45-49	50+	N.S.
15-19	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	X,XXX,XXX	
20-24											
25-29											
30-34											
35-39											
40-44											
45-49											
50-54											
55-59											
60-64											
65-69											
70-74											
75-79											
80-84											
85-89											
90-94											
95+											
N.S.											
TOTAL											

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Table 9. Females bearing children during the preceding 24 months by 5-year age groups and month of the birth

Issue | Page 9 Annex 1

Date

Author

AGE GROUP	TOTAL	LAST 12 MONTHS											
		JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT.	OCT.	NOV.	DEC.
15-19	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
20-24													
25-29													
30-34													
35-39													
40-44													
45-49													
50+													
N.S.													
TOTAL													

	TOTAL	13 - 24 MONTHS											
		JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT.	OCT.	NOV.	DEC.
15-19													
20-24													
25-29													
30-34													
35-39													
40-44													
45-49													
50+													
N.S.													
TOTAL													

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Table 10. Females "not stated" as to date of last birth by 5-year age groups and number of children ever born

Issue | Page 10 Annex 1

Date

Author

AGE GROUP	1	2	3	4	5	6	7	8	9	10+	N.S
15-19	X,XX,XX	XX,XX	XX,XX	XX,XX	XX,XX	XX,XX	XX,XX	XX,XX	XX,XX	XX,XX	XX,XX
20-24											
25-29											
30-34											
35-39											
40-44											
45-49											
50+											
N.S											
TOTAL											

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Table 11. Deaths of members of the household during the preceding 24 months by sex, age group and month of occurrence

Issue | Page 11 Annex 1

Date

Author

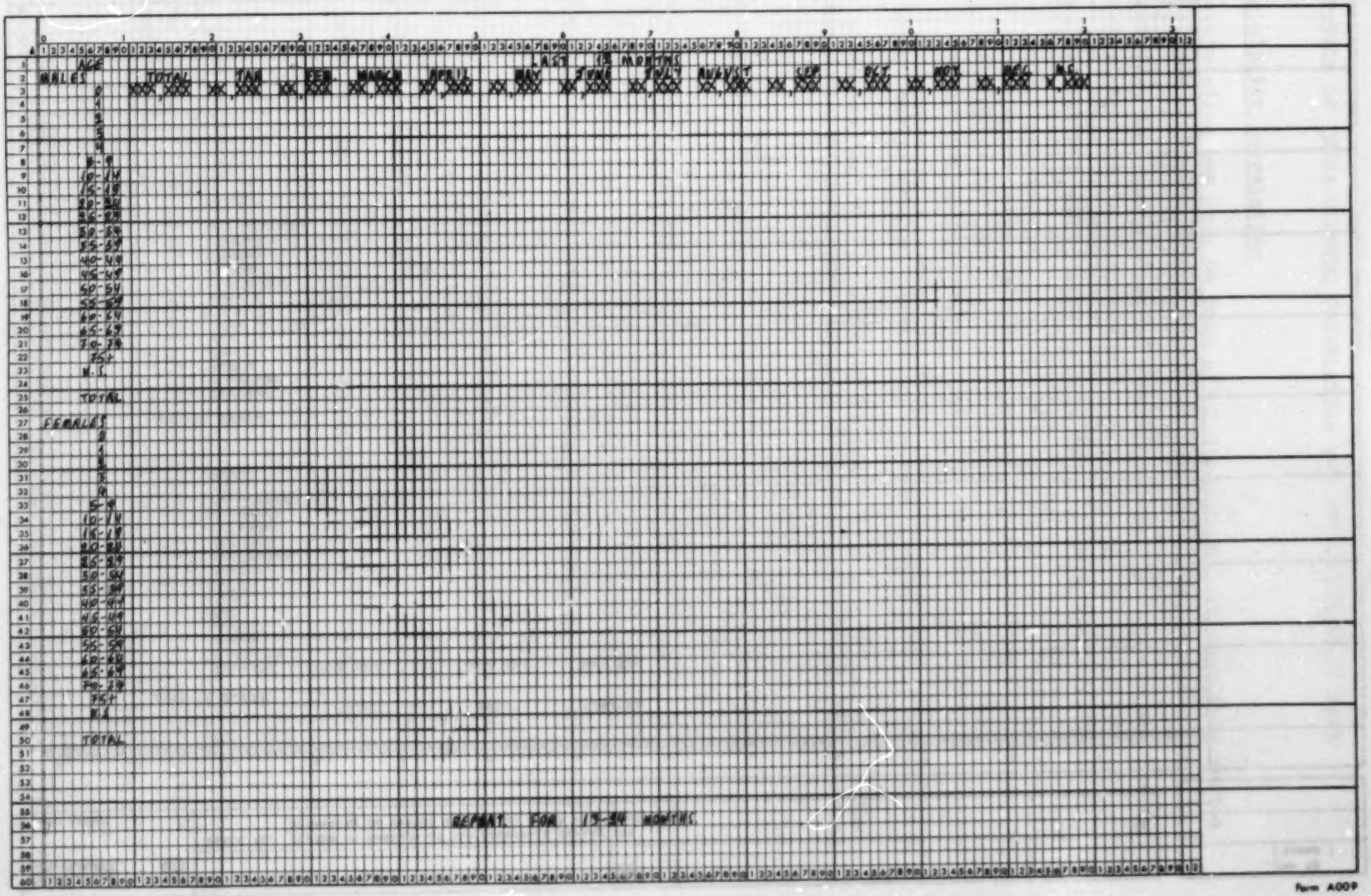

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Table 12. Births to members of the household during the preceding 24 months by sex and month of occurrence

Issue | Page 12 Annex 1

Date

Author

	TOTAL	MALES	FEMALES
LAST 12 MONTHS			
JANUARY	XXX,XXX	XXX,XXX	XXX,XXX
FEBRUARY			
MARCH			
APRIL			
MAY			
JUNE			
JULY			
AUGUST			
SEPTEMBER			
OCTOBER			
NOVEMBER			
DECEMBER			
NOT STATED			
TOTAL			
13 - 24 MONTHS			
JANUARY			
FEBRUARY			
MARCH			
APRIL			
MAY			
JUNE			
JULY			
AUGUST			
SEPTEMBER			
OCTOBER			
NOVEMBER			
DECEMBER			
NOT STATED			
TOTAL			

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ANNEX 2

COMPUTATION OF INTRA-CLUSTER CORRELATION AND OPTIMUM CLUSTER SIZE

1. Intra-cluster correlation

The computation can only be made after the survey. It therefore serves essentially as a guide for sample design in future surveys.

Suppose that the clusters are of variable size, the i-th cluster having a population of n_i ($i = 1, 2 \ldots m$).

We assume that the variable of interest is a demographic rate 1/, namely:

$$r = \frac{\text{Number of events}}{\text{Number of persons}} = \frac{x}{n}$$

x_i being the number of events reported in the i-th cluster.

We also assume that the rate can be regarded as a proportion p_i, in the i-th cluster. The within-cluster variance is therefore given by the binomial formula:

$$V_i = \frac{1}{n_i} p_i (1 - p_i)$$

$$= \frac{1}{n_i} \frac{x_i}{n_i} \left(1 - \frac{x_i}{n_i}\right)$$

We now write $\bar{x} = \frac{1}{m}\sum_i x_i$, $\bar{n} = \frac{1}{m}\sum_i n_i$, $r = \bar{x} / \bar{n}$

and $$A = \sum_i (x_i - \bar{x})^2 + r^2 \sum_i (n_i - \bar{n})^2 - 2r \sum_i (x_i - \bar{x})(n_i - \bar{n})$$

$$B = \sum_i x_i (1 - x_i/n_i)$$

The intra-cluster correlation of the rate r is then given by:

$$\delta = \frac{m A - (m - 1) B}{m A + \bar{n}(m - 1)B}$$

1/ The value of the intra-cluster correlation will be the same whether r is defined as the rate per person or per 1000 persons.

EXAMPLE

Suppose there are 3 clusters with the following data:

	Cluster 1	Cluster 2	Cluster 3
No. persons n_i	1000	600	500
No. events x_i	55	20	30

Computations

$$m = 3, \quad \bar{n} = 700, \quad \bar{x} = 35, \quad r = \frac{35}{700} = \frac{1}{20}$$

Grappe	$(x_i - \bar{x})$	$(x_i - \bar{x})^2$	$(n_i - \bar{n})$	$(n_i - \bar{n})^2$	$(x_i - \bar{x})(n_i - \bar{n})$
1	+ 20	400	+ 300	90 000	+ 6 000
2	- 15	225	- 100	10 000	+ 1 500
3	- 5	25	- 200	40 000	+ 1 000
TOTAL	0	650	0	140 000	+ 8 500

$$A = 650 + \frac{1}{400} \times 140\,000 - \frac{1}{10} \times 8\,500 = 150$$

$$B = 55 \times 0.945 + 20 \times 0.967 + 30 \times 0.940 = 100$$

$$\delta = \frac{3 \times 150 - 2 \times 100}{3 \times 150 + 700 \times 2 \times 100} = 0.002$$

Interpretation

The rates per 1000 population in the 3 clusters are seen to be

55; 33; 60

If the events occurred at random the rate would vary between clusters according to the binomial variance. For a rate of 50 (i.e. 1/20) and for clusters of size 700 (the average size in the present case), the rates in the 3 clusters would vary around their mean of 50 with a standard deviation of

$$1000 \sqrt{\frac{1}{700} \times \frac{1}{20} \times \frac{19}{20}} = 8.25$$

In reality, the 3 rates shown vary somewhat more than this. This reflects the fact that the intra-cluster correlation is small and positive, implying a between-cluster variance somewhat larger than can be accounted for by the random variation within clusters.

2. Optimum cluster size

The error variance in a 2-stage sample, or a single stage sample of complete clusters, is of the form

$$V = \frac{k}{mn}\left[1 + \delta\,(n - 1)\right] \qquad \text{—(1)}$$

where k is a constant, m is the number of primary units or clusters in the sample and n is the number of ultimate units (persons) selected in each cluster. If the sample covers the whole of each selected cluster then n is the cluster size. It is assumed in any case that n is constant in all clusters.

As a rough approximation we may assume that the cost C of the survey may be broken down into 3 factors:

C_o, a constant overhead independent of the sample design;

$C_1 m$, a cost proportional to the number m of clusters selected - cost of mapping, travel to the cluster, finding accommodation, etc.

$C_2 mn$, a cost proportional to the number of persons covered by the survey within the sample clusters - essentially the cost of interviewing and travel between interviews in the same cluster.

Thus: $$C = C_o + C_1 m + C_2 mn \qquad \text{—(2)}$$

The optimum cluster size, or in the case of a 2-stage sample the optimum number to select in each sample cluster, is that value of n which minimizes the variance V for given total survey cost C.

Eliminating m between equations (1) and (2), we obtain

$$V = \frac{k\,(C_1 + n\,C_2)}{(C - C_o)\,n}\left[1 + \delta\,(n - 1)\right]$$

Differentiating with respect to n and setting $\frac{dV}{dn} = 0$, we obtain

$$n_{opt}^2 = \frac{C_1}{C_2} \cdot \frac{1 - \delta}{\delta}$$

$$\doteq \frac{C_1}{C_2} \cdot \frac{1}{\delta} \qquad \text{—(3)}$$

In most African surveys it is probably true to say that the limiting factor has been the number of enumerator days available to carry out the work, rather than the cost. This is because, on the one hand, the number of enumerators who can be effectively put to work is limited by the supervising capability of the senior staff and, on the other, the total time available for the field work is fixed by climatic or administrative constraints. However, the above reasoning can be applied to time as easily as to cost. T_1, the number of enumerator-days involved in each cluster independently of the work load of interviews within it, depends mainly on whether enumerators work singly or in teams. For single enumerators the figure is perhaps 2 or 3 enumerator-days, while for teams of 4 or 5 enumerators it would correspondingly vary between 8 and 15 enumerator-days. $1/T_2$ the number of persons covered per day per enumerator, once he has started work in the cluster, ranges perhaps from 25 to 50. Thus, if we write $T = T_1/T_2$, the value of T would be, for individually working enumerators from 50 to 150, and for teams from 200 to 750. T might be termed the working time ratio between the first stage (clusters) and the second (persons). The table below shows some typical values of n_{opt} computed from formula (3) above.

	Time ratio T between 1st and 2nd stages	Intra-cluster correlation			
		0.001	0.002	0.003	0.005
Enumerators	50	224	158	129	100
working	100	316	224	183	141
singly	150	387	274	224	173
Enumerators	200	448	316	258	200
working	300	549	388	316	240
in teams	500	707	500	408	316
of 4 or 5	750	866	612	500	387

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